MBON All-Hands Meeting
Silver Spring, MD
May 03, 2016

MBON

Marine Biodiversity Observation Network

Sanctuaries MBON

Monterey Bay,
Florida Keys, and
Flower Garden Banks
National Marine Sanctuaries

Principal Investigators:
Frank Muller-Karger (USF)
Francisco Chávez (MBARI)

The Sanctuaries MBON pilot

Outline

- *Data management*
- *Outreach*
- *International dimensions*
- *Next steps*
- *Project successes and challenges*

- *Working "X-MBON"*

The Sanctuaries MBON pilot: primary goals

- Develop a practical and sustainable pilot MBON with the *National Marine Sanctuaries Program*
- Integrate with, augment, and synthesize information from ongoing programs
- Develop technologies for biodiversity assessments:
  - environmental DNA (eDNA)
  - Remote sensing time-series: *Seascapes*
- Integrate biological data into national/international databases
- Plan to transition to an operational system

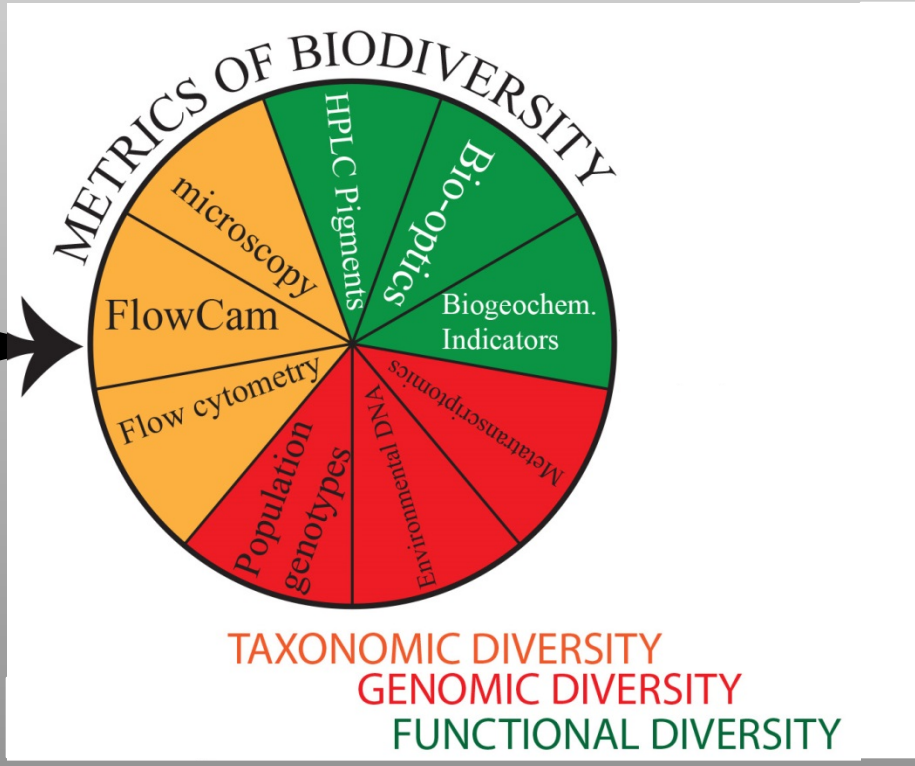
The importance of biodiversity

Ecological diversity is intimately tied to habitat diversity and to the capacity of organisms to adapt and survive as a species.

Understanding habitat and biological diversity and function is fundamental to define conservation strategies

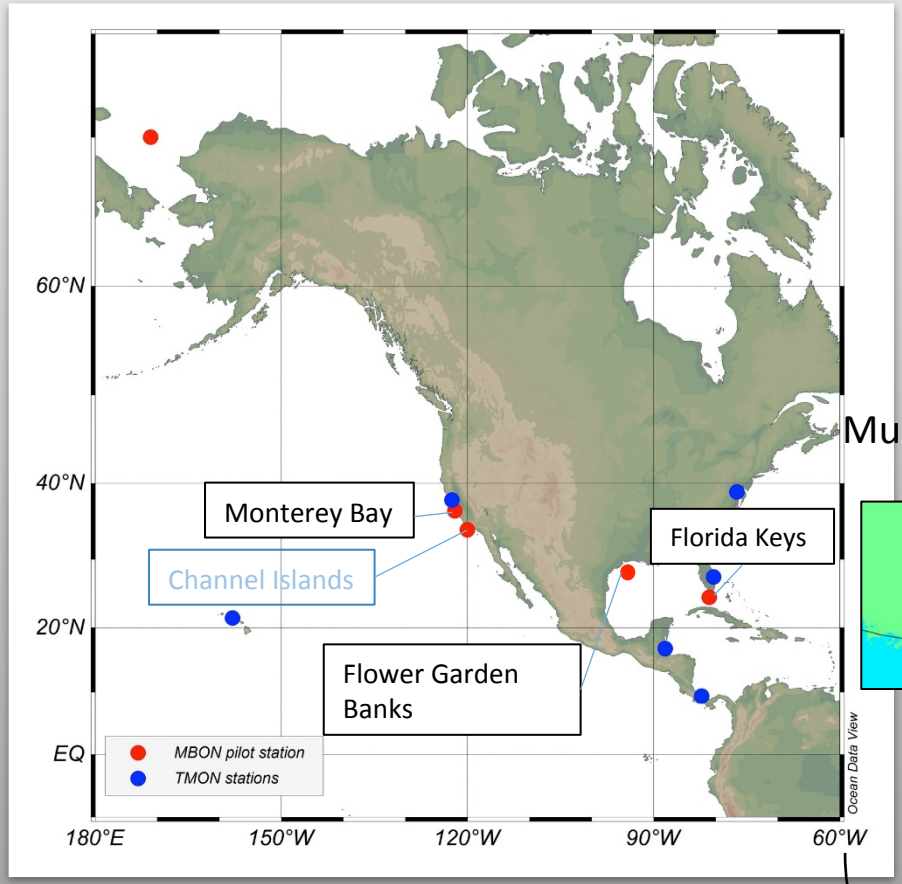
Diversity defines the function and health of ecosystems

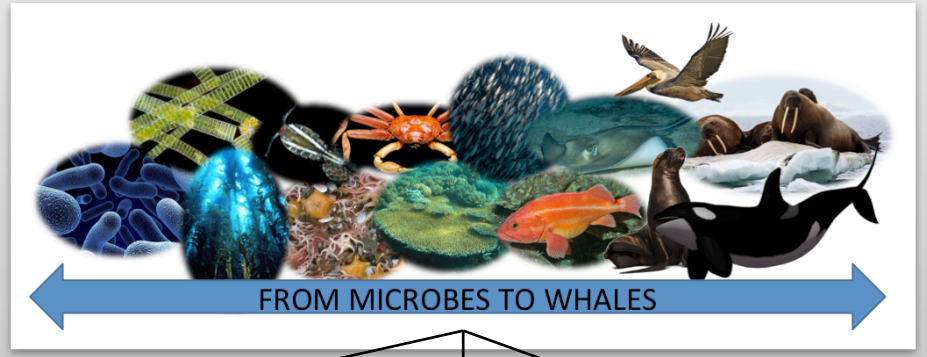
- Taxonomic and Phenotypic diversity:
  - An expression of the diversity in habitats and niches
- Genetic diversity - variability in DNA that gives species the capacity for adaptation, speciation and resilience in the face of stress



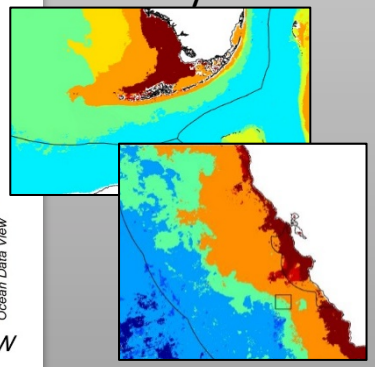
MBON Components

The Sanctuaries MBON pilot concept





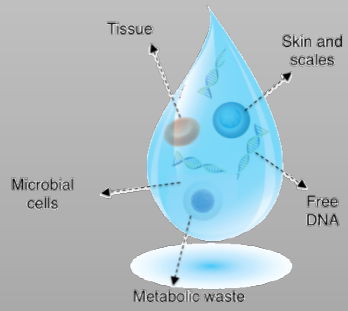
Multivariate seascape analysis



Data Integration:

- IOOS/GOOS
- I-OBIS
- GEO BON

eDNA



Web-based information system

Supports

- Sanctuary Condition Reports
- Resource managers and policy makers
- Scientists and educators

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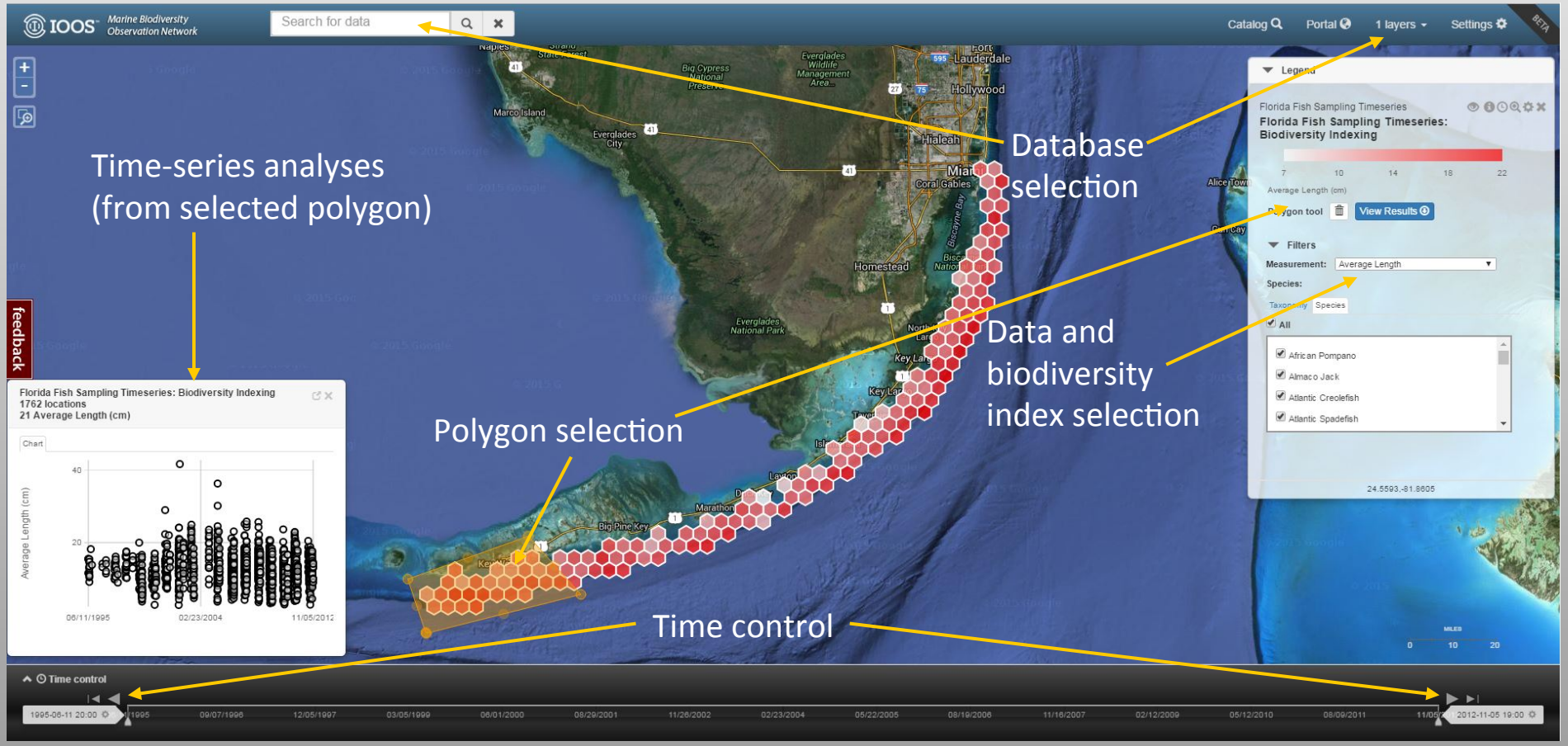
IOOS Data management

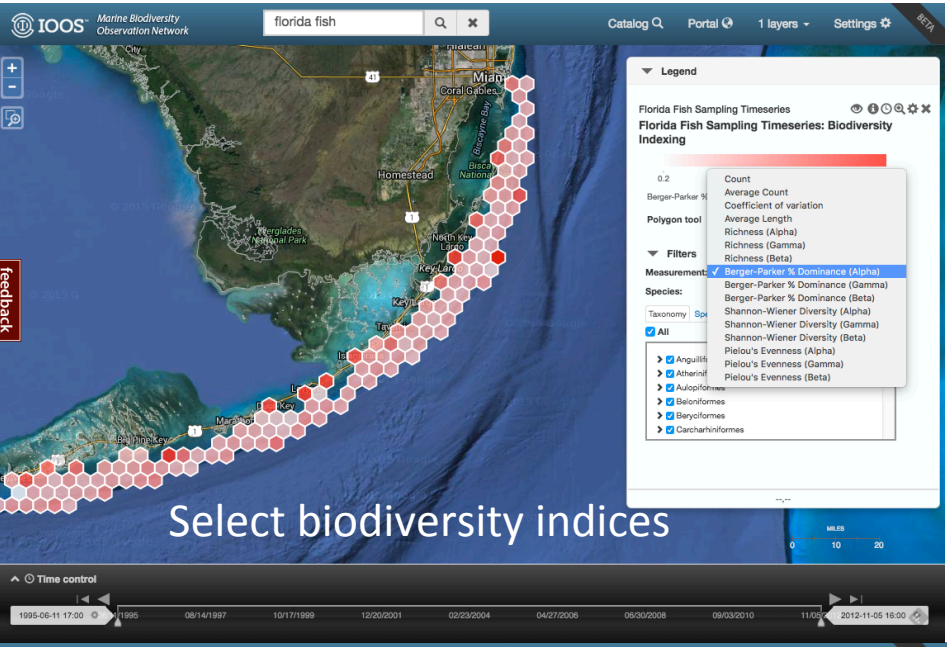
- Data enrollment strategies being applied
  - Enrolling historical and new data:
    - **Reef Visual Census data (RVC)**
    - **Coral reef cover Florida Keys (CREMP)**
    - **Rockfish data for Monterey Bay NMS / California**
    - Daily River Discharge for US GOM Rivers – first record to current day in NetCDF*.
    - Water Quality Parameters for 5 Gulf States – all known records to 2014 in NetCDF*.
    - FWRI/FWC Provided 32 Data Layers and 7 table relevant to FKNMS MBON
    - Similar numbers of data for MB
    - Etc.
- Ancillary bio-optical data being submitted to NASA SeaBASS
- 2005-2008 Monthly SeaScapes produced by Maria Kavanaugh (WHOI) on hand in NetCDF
- Satellite Data Archives Identified (USF - IMaRS)
- Development of a pilot biodiversity mapping tool
- Data Management Plan in Development
- New HPC ERDDAP/TDS Servers on 10GB line being deployed*

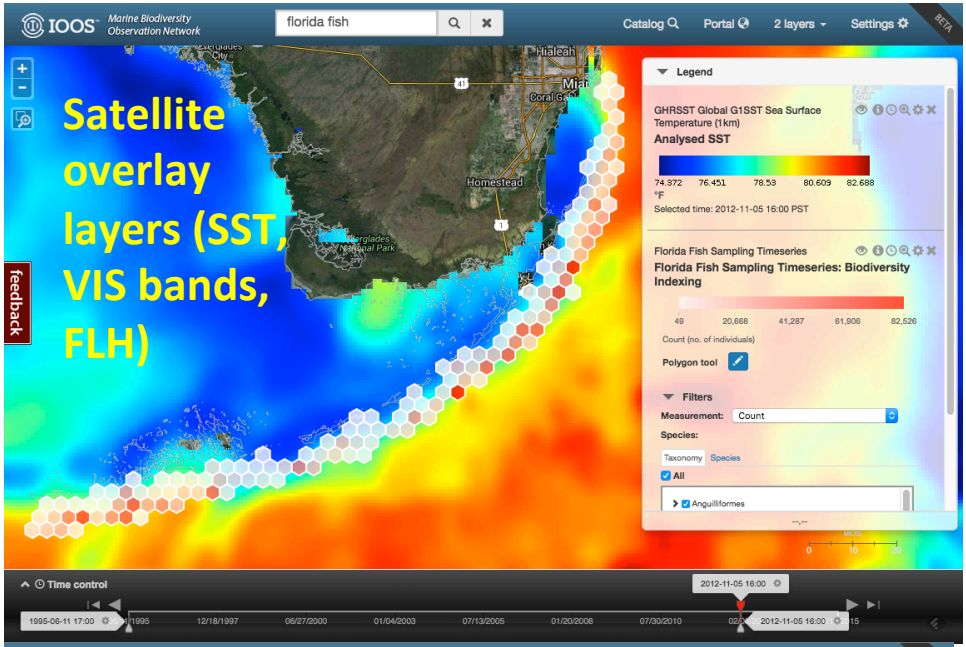
IOOS DMAC:
Data Management and Communications

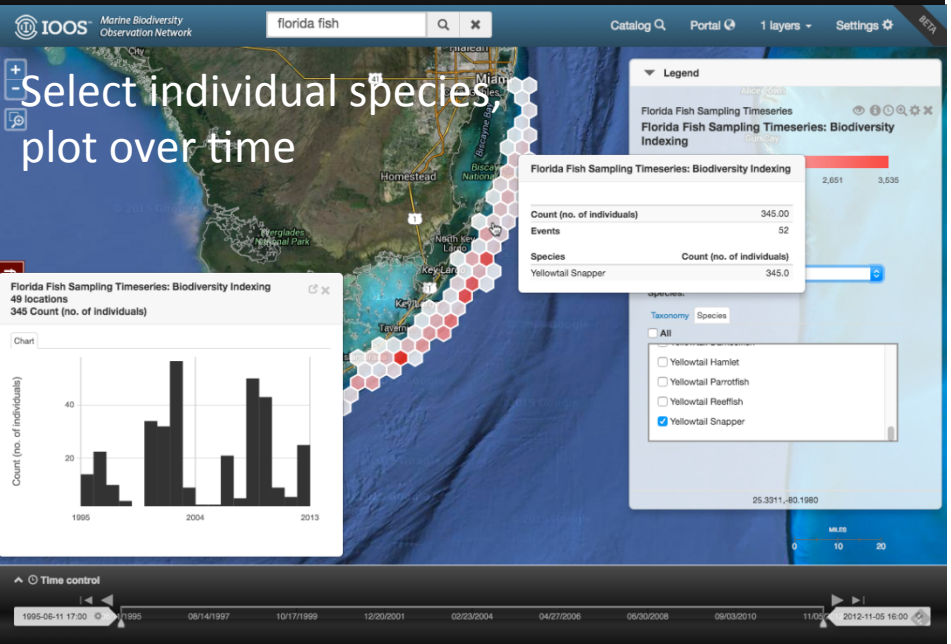


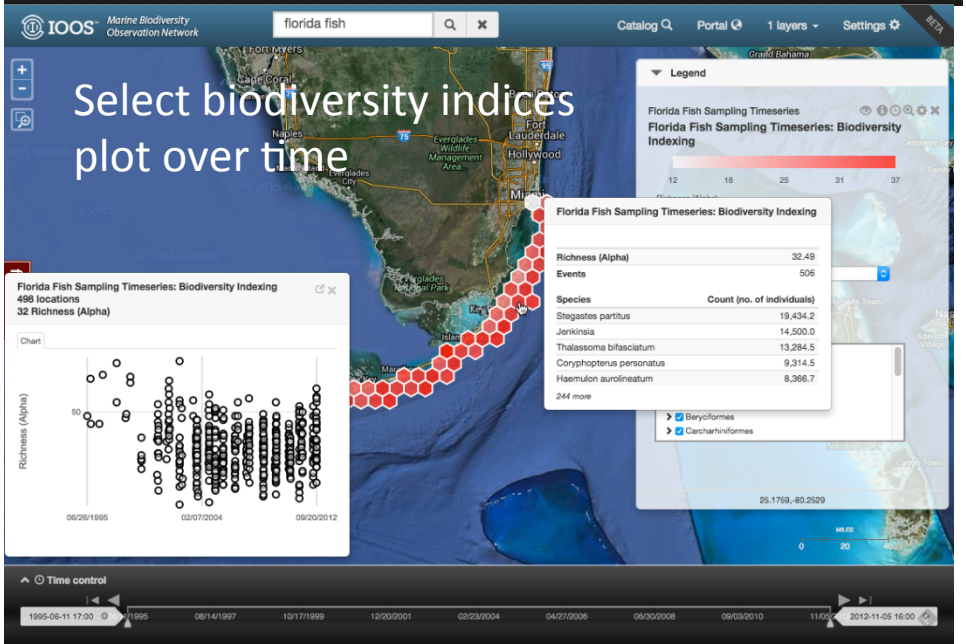
Example: NOAA's SEFSC Reef Visual Census: Average fish length (cm) distribution. Figure shows time-varying fish length within selected polygon

DMAC: Development of MBON Visualization









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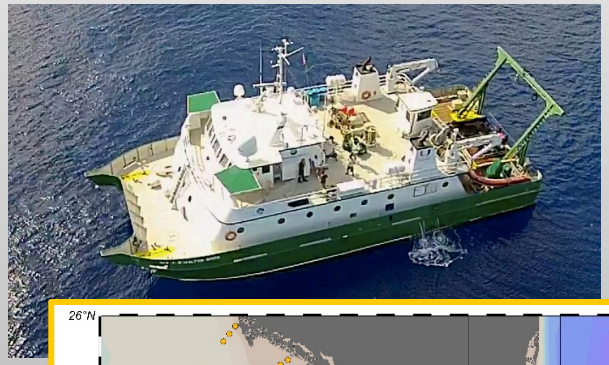
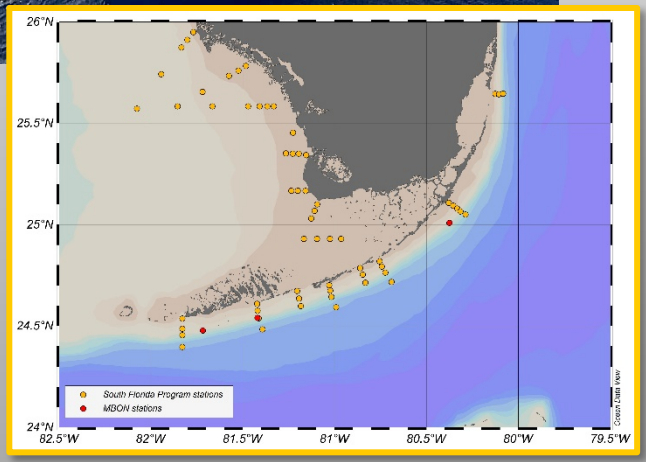
Field programs

Complement Multiple Data Collection Efforts in Each Sanctuary



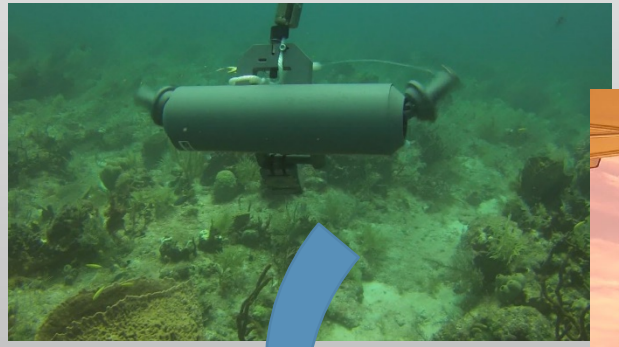


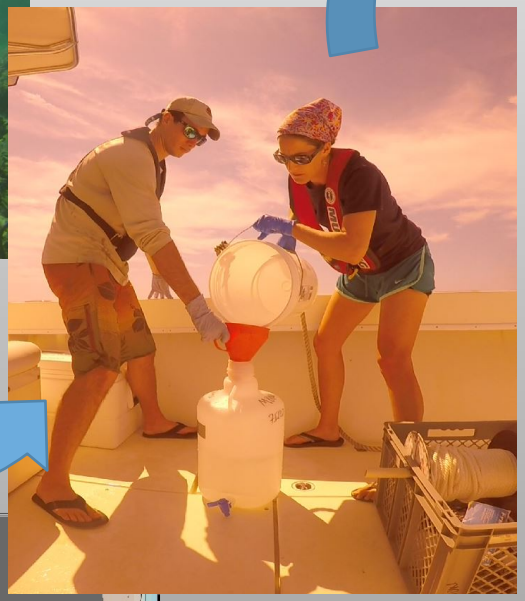
South Florida Program run by AOML partners:

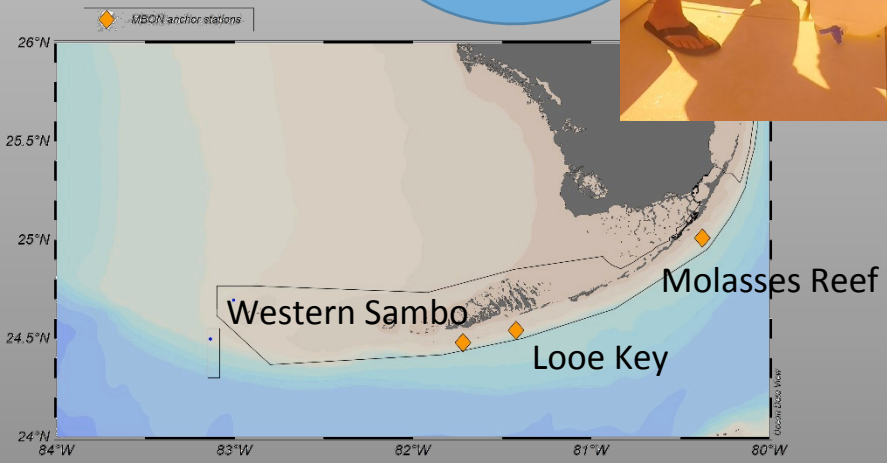
- Chris Kelble–bio oc./prim prod
- Lindsey Visser
- Libby Johns – phys oc. analyses

Florida Keys field program

FKNMS and AOML partners have enabled field and lab operations in the Keys since August 2015





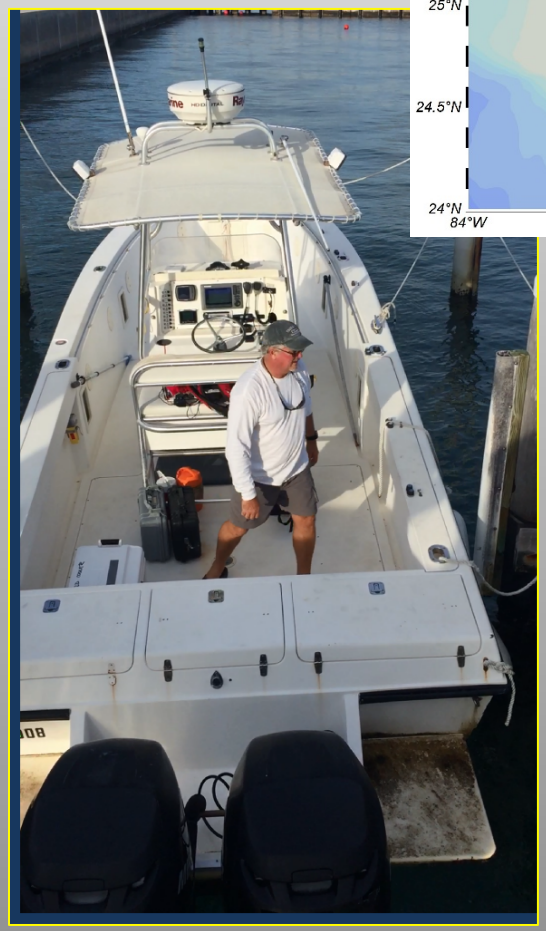


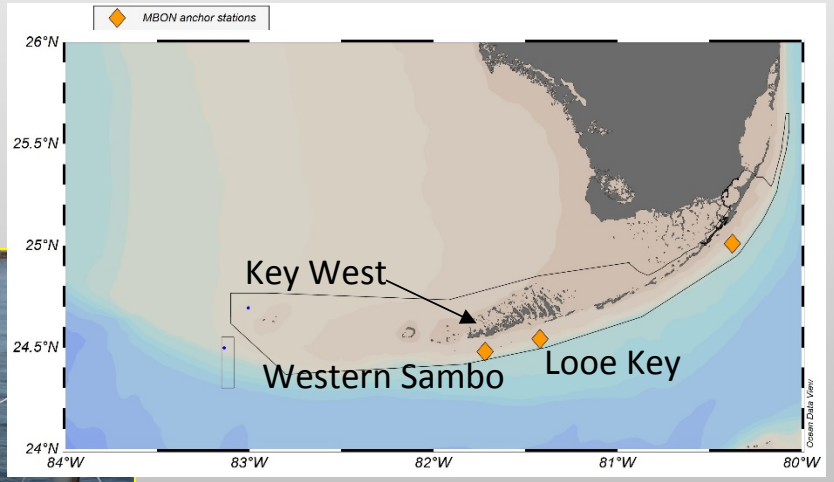
Sample collection and processing in FKNMS Key West facility (conducted by NOAA staff):

- Lonny Anderson
- Rosemary Abbitt
- Beth Dieveney
- Sean Morton

NOAA facility in Key West supports sampling at W. Sambo and Looe Key

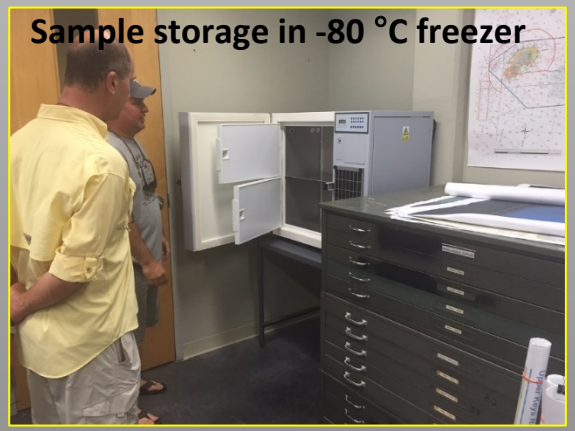
- NOAA facility available for MBON at Key West.
- Sample processing takes ~ 3 hours
- Lead: Lonny Anderson



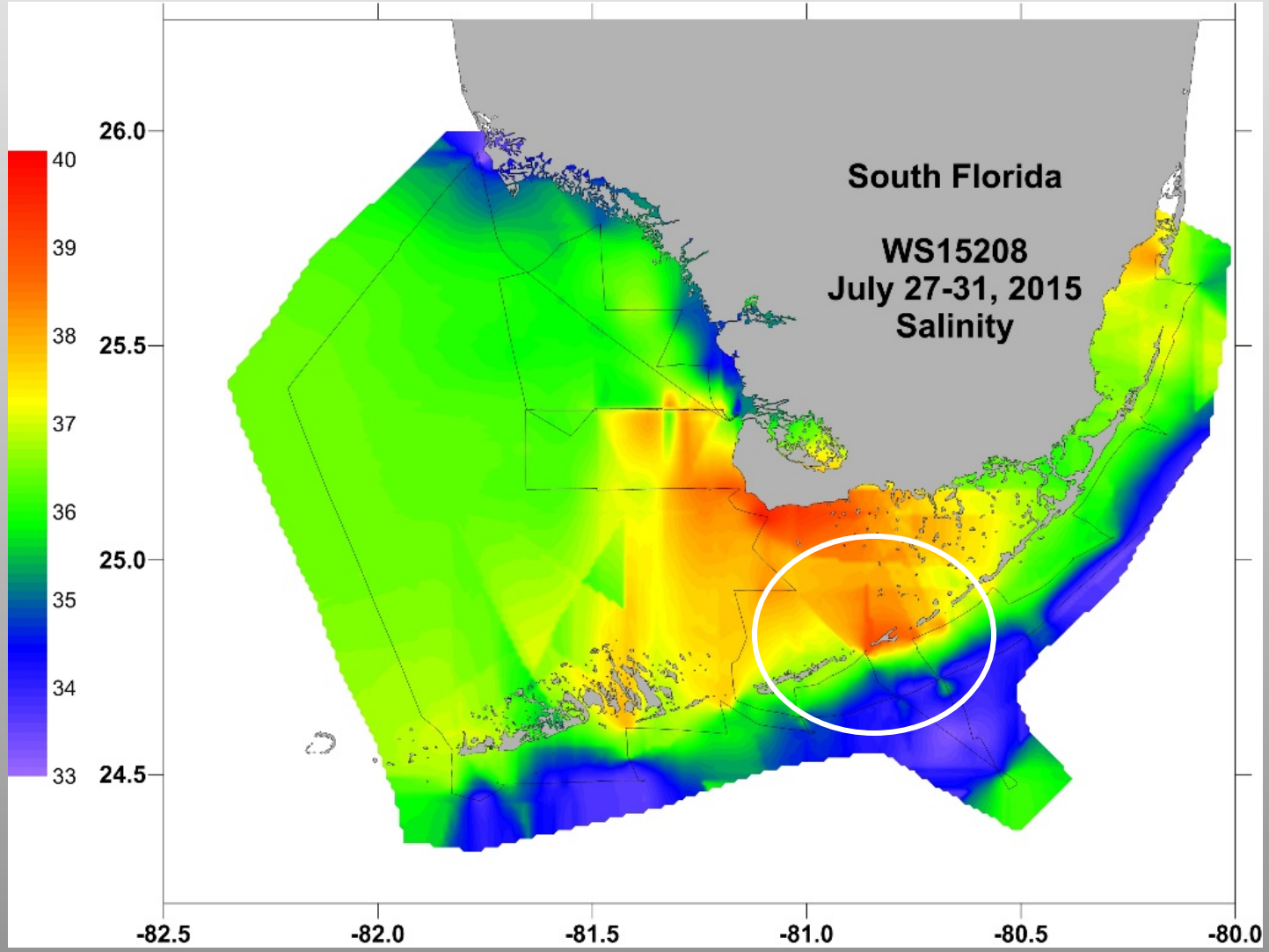


- 30 ft. boat
- Three FKNMS personnel
- ~ 1 hour to Looe Key
- ~ ½ hour to Western Sambo
- Sampling takes < 30 min.

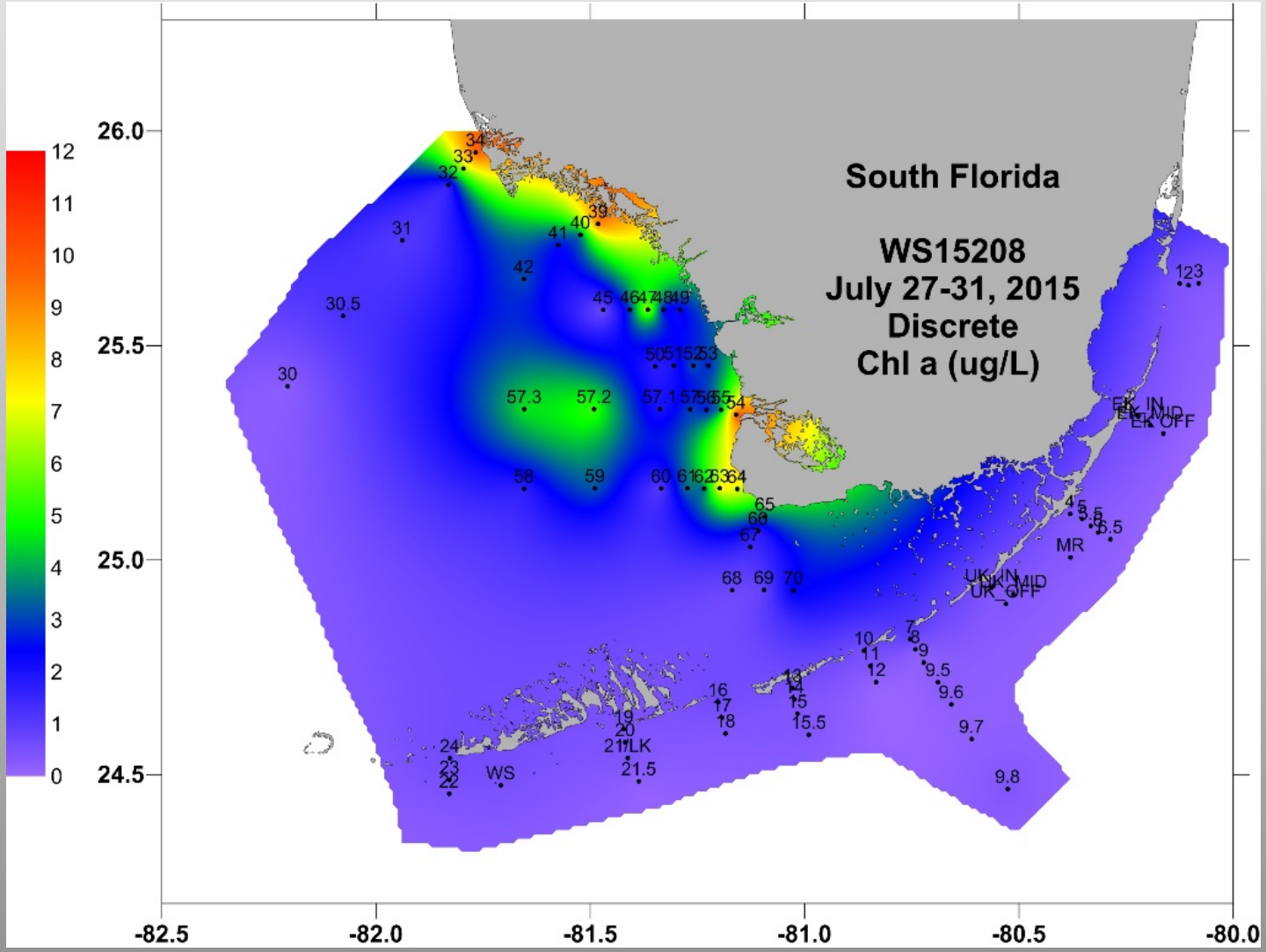
- **Sample storage in -80 °C freezer**



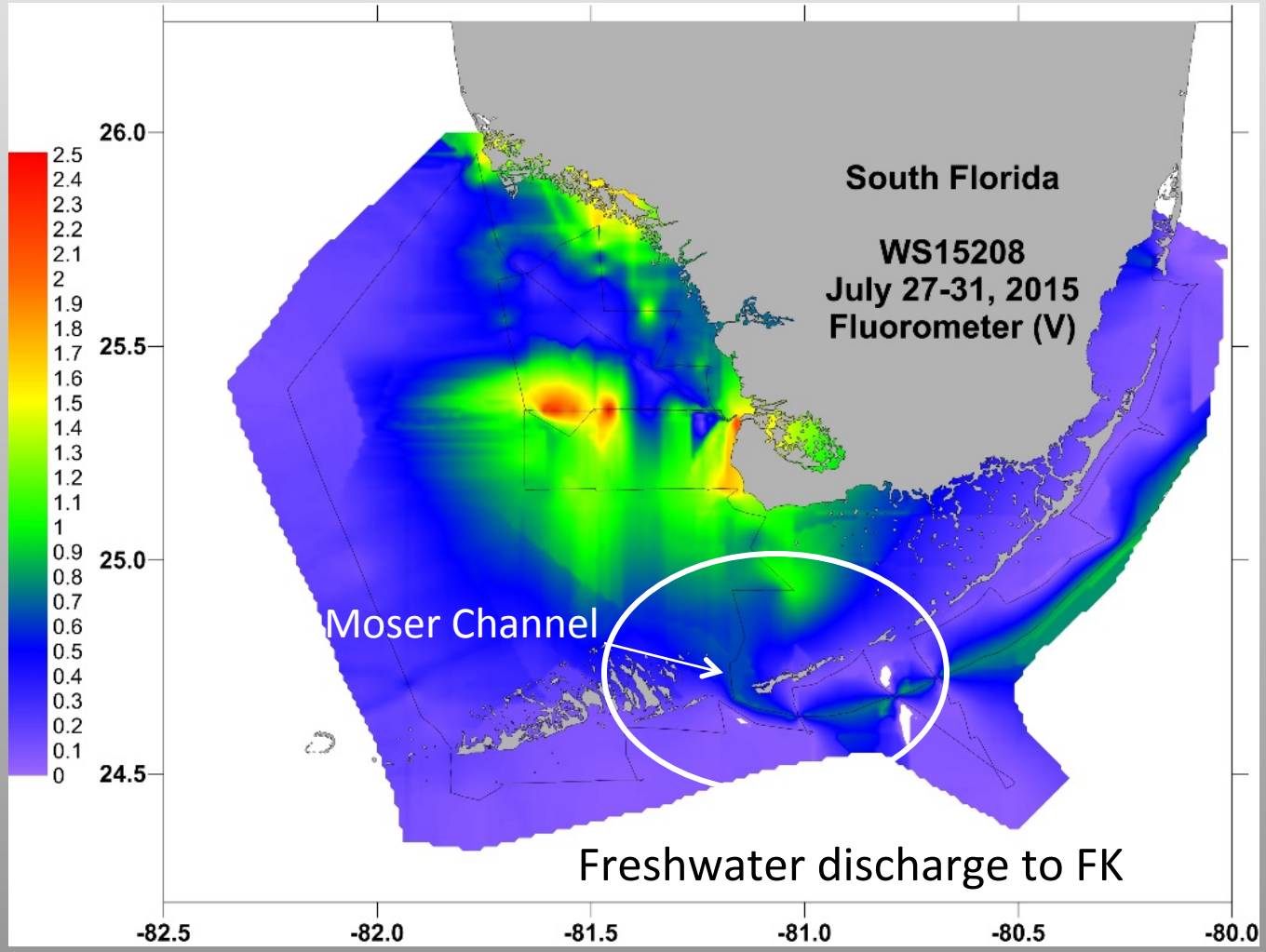
High salinity event during July 27-31, 2015, in Florida Bay and FKNMS



Discrete Chl-a during July 27-31, 2015, in Florida Bay and FKNMS

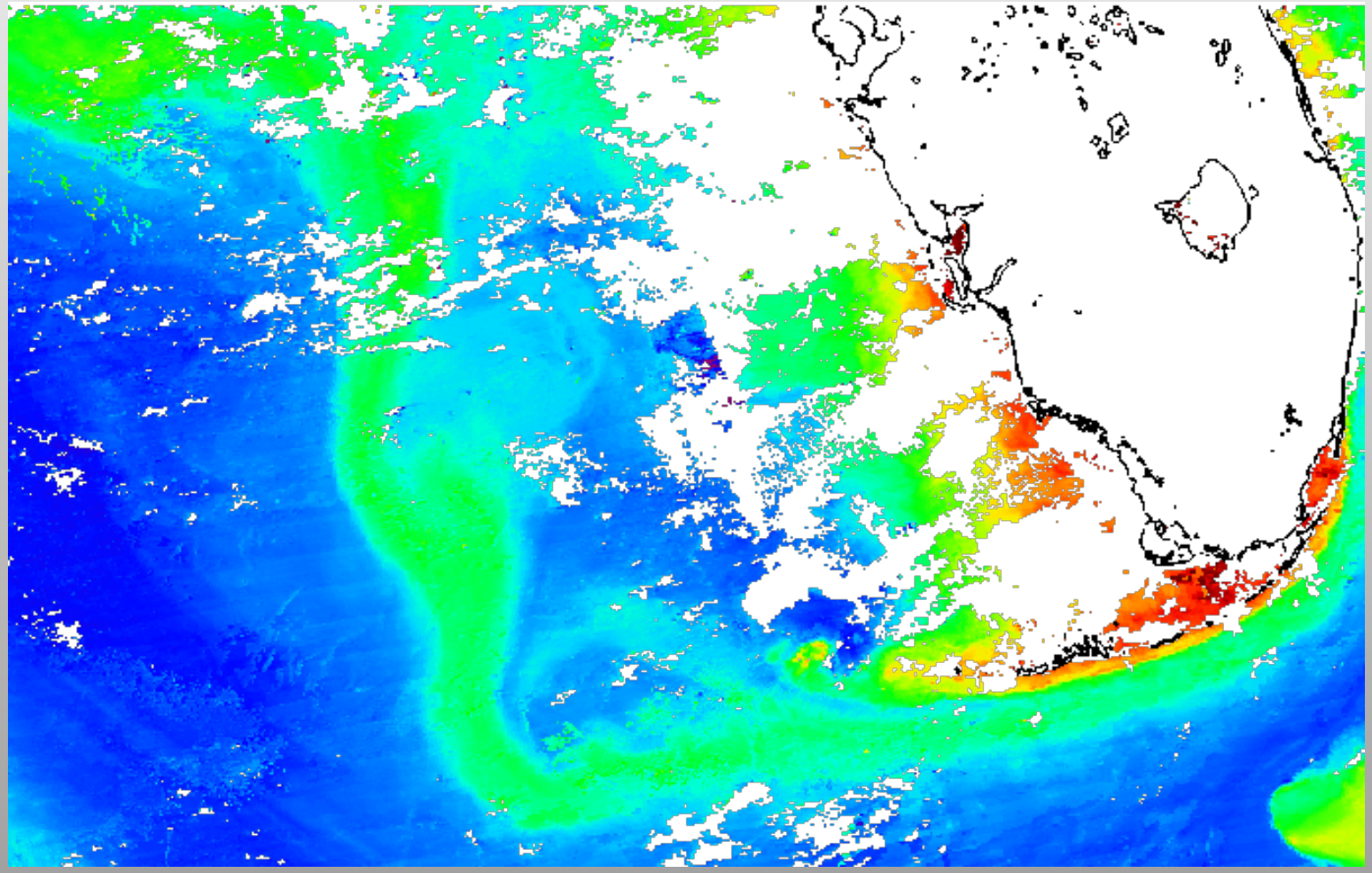


Chl-a fluorescence during July 27-31, 2015, in Florida Bay and FKNMS



Mississippi River plume intrusion during July cruise

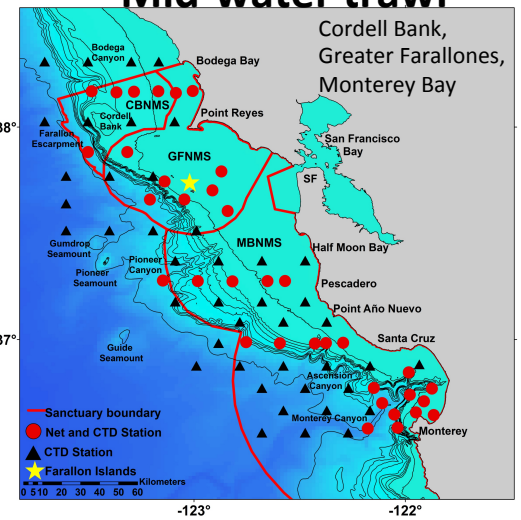
MODIS Aqua 1km Chl-a composite (7/23/15-7/27/15)



NOAA-NMFS Rockfish Recruitment and Ecosystem Assessment Survey

May-June

Mid-water trawl



Sampling Stations grouped by "Eco-regions":

Monterey Bay

Oceanic

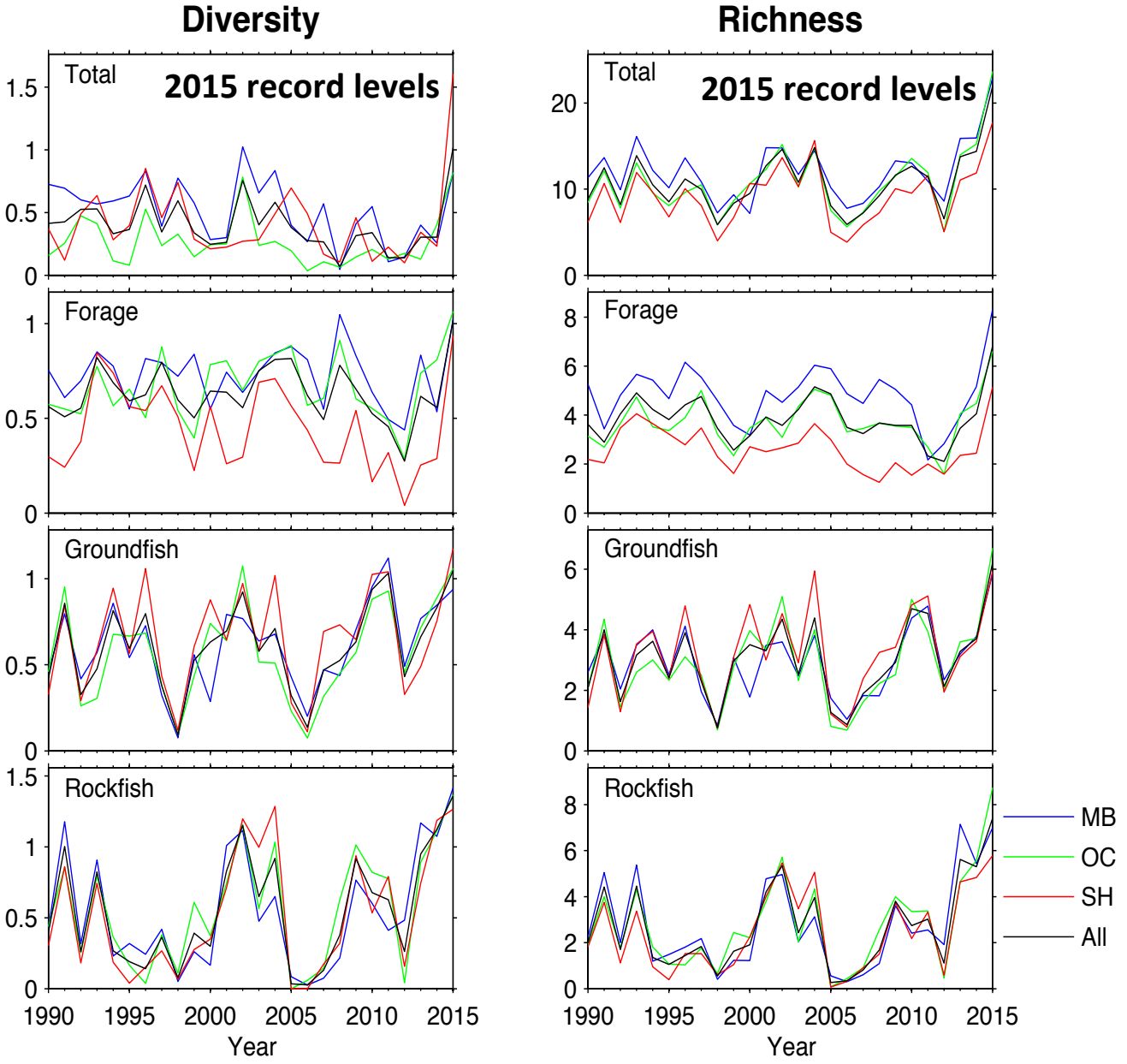
Shelf

All (combined)

Time series are calculated for total species and major guilds

130 total taxa

Santora et al. In prep.



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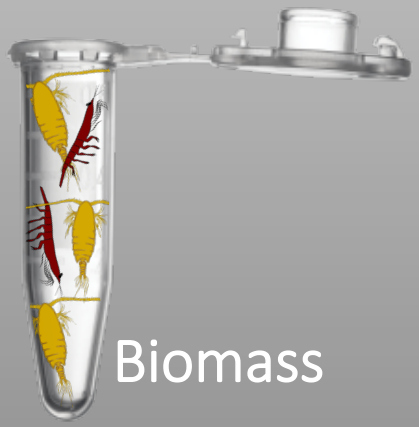
eDNA – A New Frontier

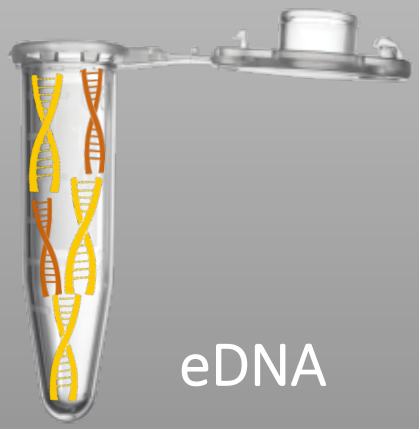
Sanctuaries MBON eDNA: vertebrates, zooplankton, and microbes

- Testing of eDNA extraction methods completed – manuscript in prep.
- Primers: selection completed for some organisms
- eDNA validation in progress (i.e. zooplankton and whales)

Microscopy: Taxonomy & counts



Biomass



eDNA

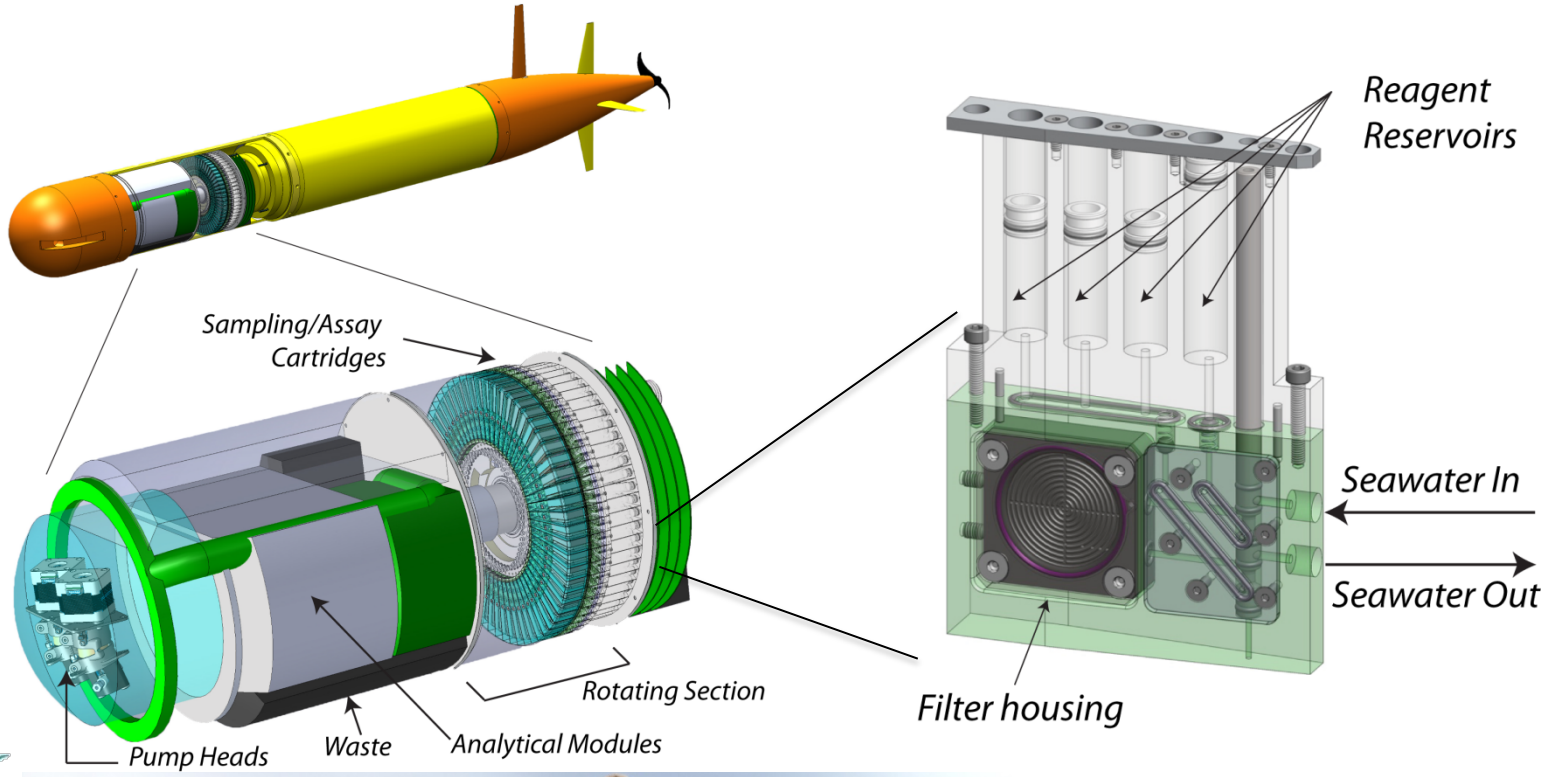
MBON Genomics Team

- Stanford – Vertebrates (12S)
- MBARI – Phyto, Zooplankton (18S, 28S, CO1)
- USF – Microbes/Viruses/Zooplankton (16S)
- FWRI – Phytoplankton (18S)
- SBCBON – Microbes (16S), fish, etc.
- AMBON – Microbes, phyto (16S, 18S)

Collaborations

- X-MBON: Santa Barbara, Alaska MBON
- NOAA Omics Research: (K. Goodwin, J. Hendee)
  - Atlantic Oceanographic & Meteorological Lab
  - Southwest Fisheries Science Center (SWFSC)

3rd Generation ESP & Long Range AUV

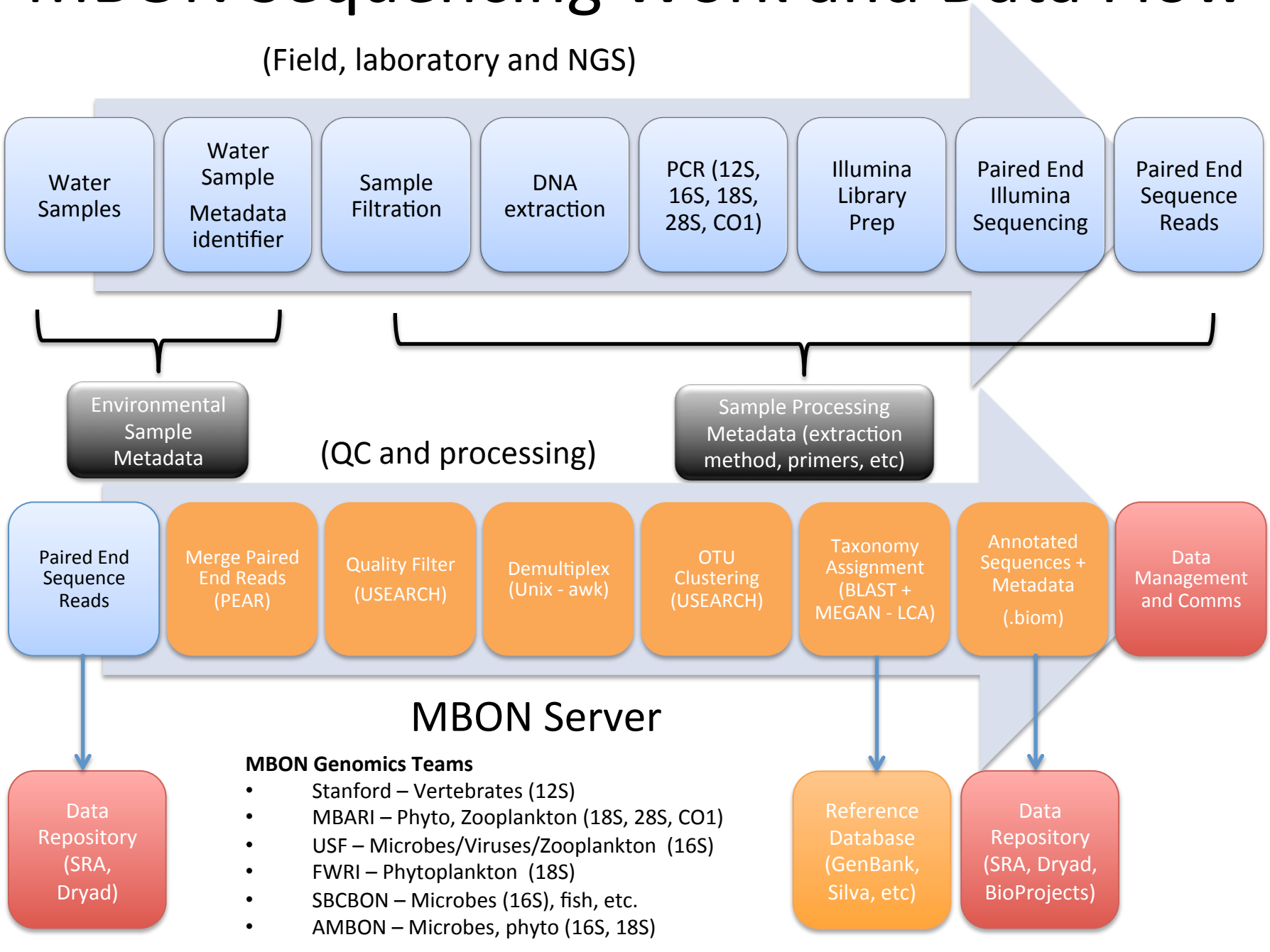


MBARI

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

ESP
MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

MBON Sequencing Work and Data Flow



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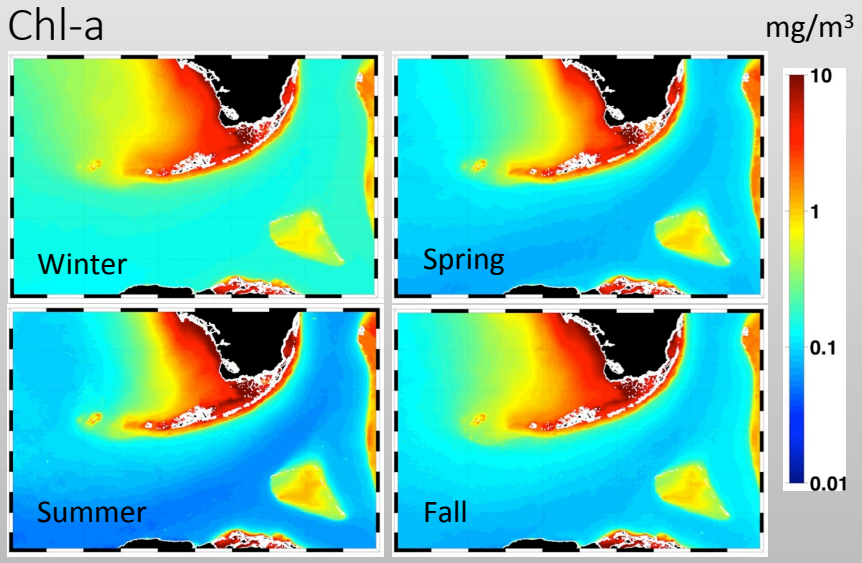
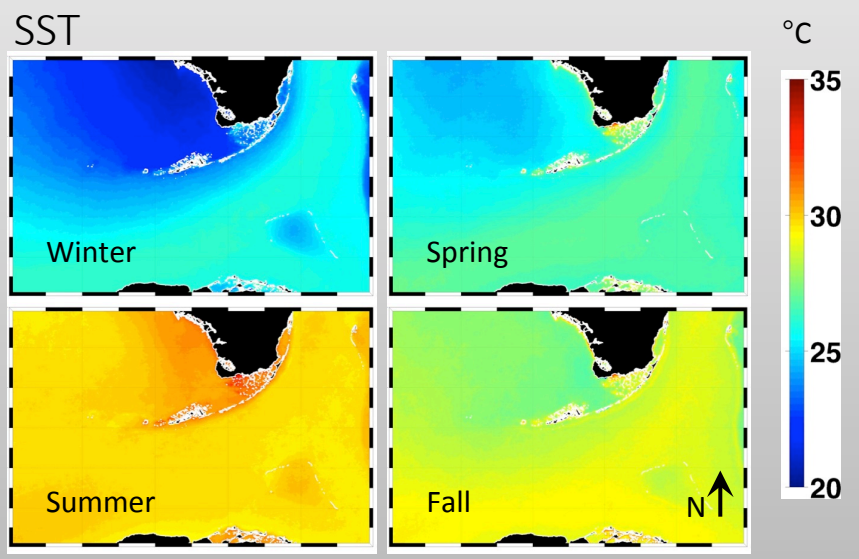
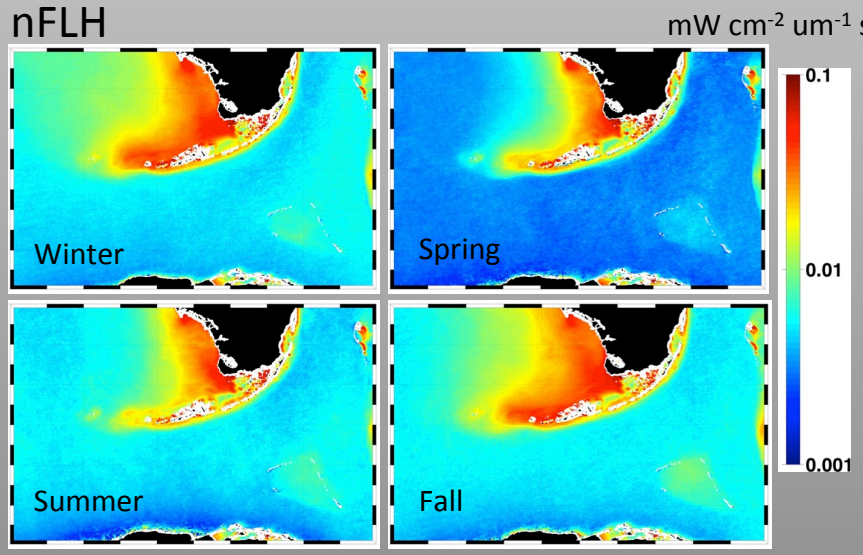
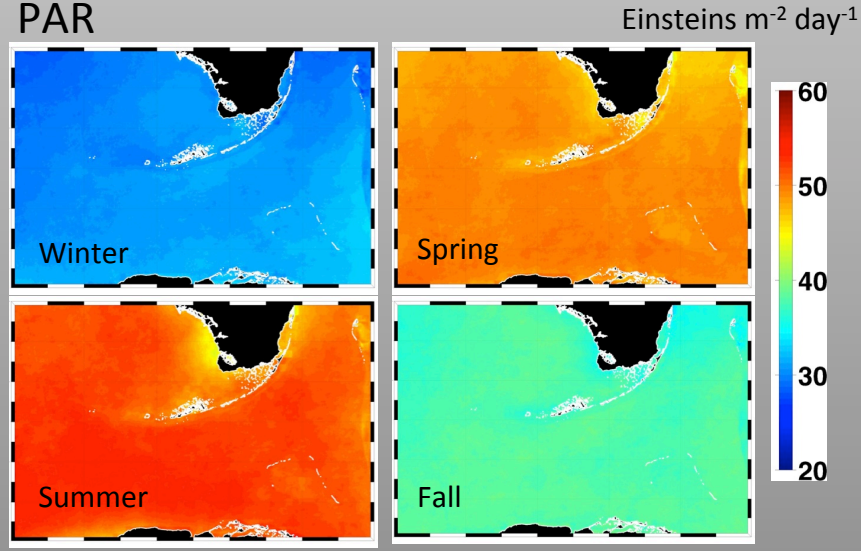
Remote Sensing of Seascapes

MODIS-Aqua 1-km seasonal climatologies (2002 -2015) for seascape analyses - FKNMS

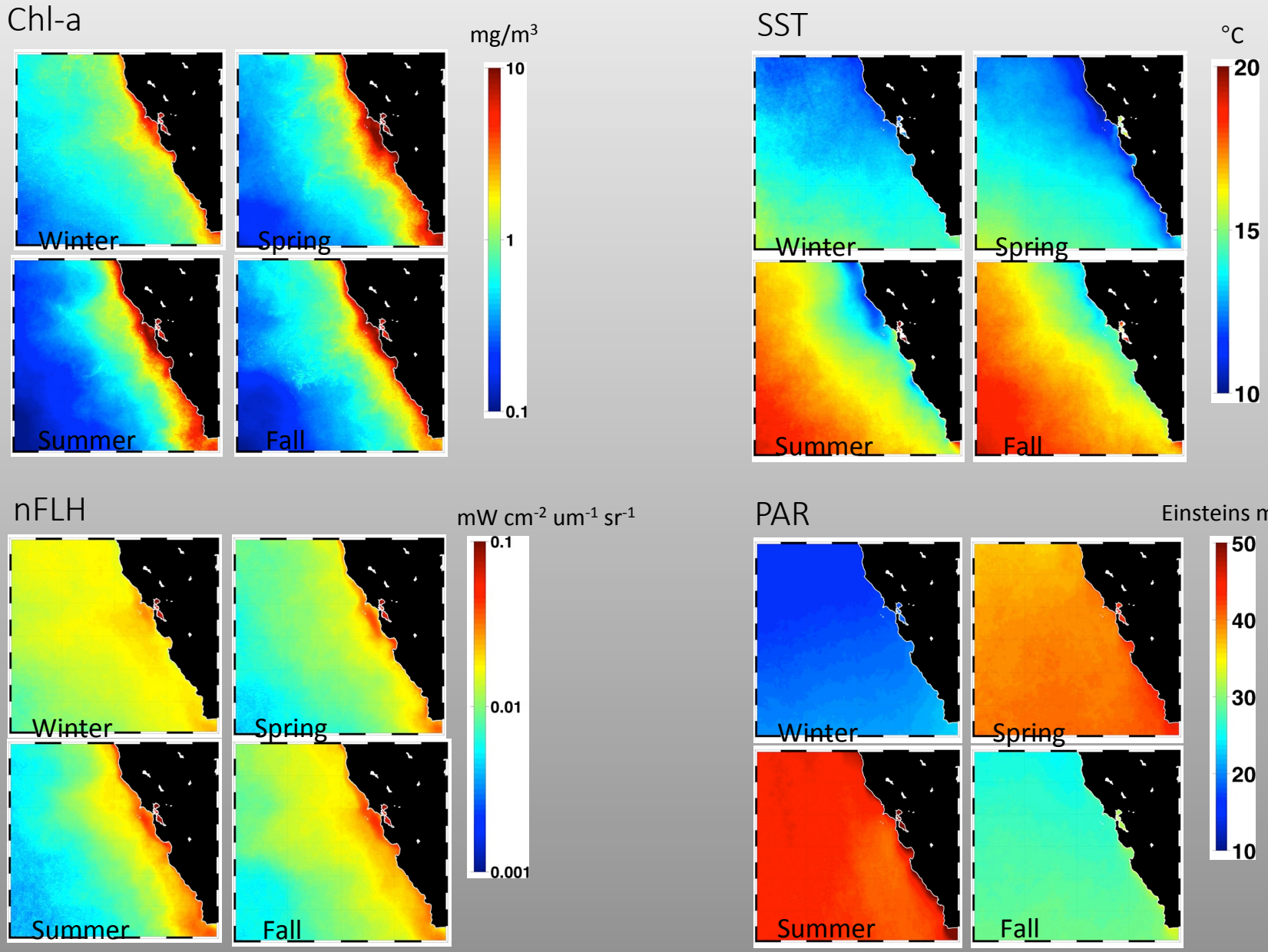








MODIS-Aqua 1-km seasonal climatologies (2002 -2015) for seascape analyses - MBNMS



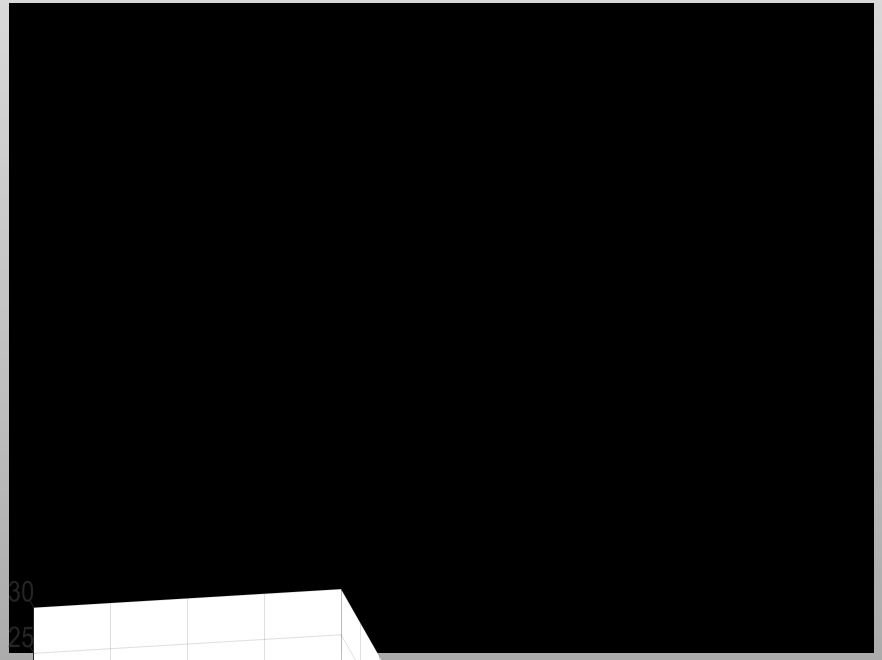
Satellite-derived seascapes
by Maria Kavanaugh (WHOI)

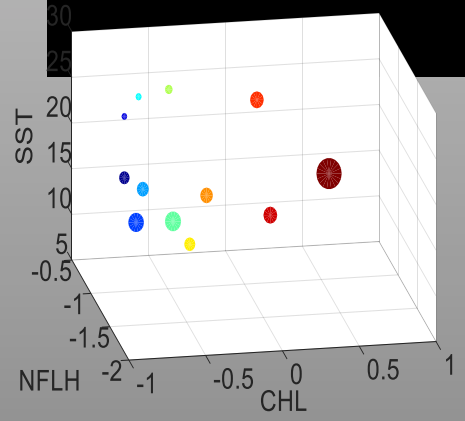
Now available:

-Fully automated processing of L1B MODIS satellite data for all MBON areas

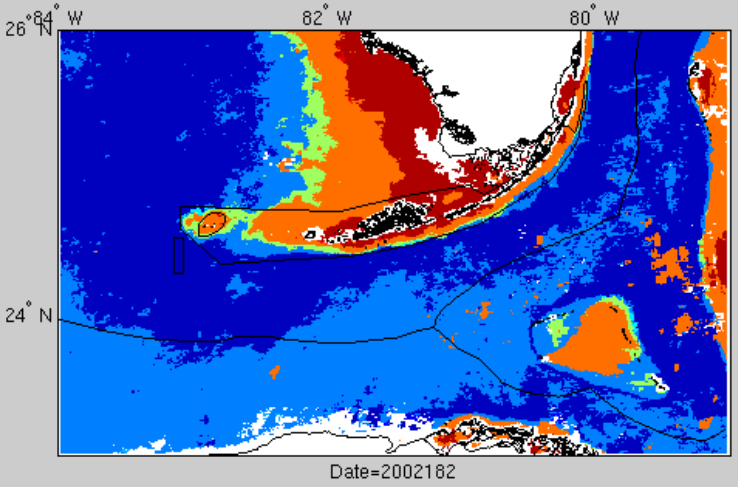
-High frequency dynamic maps

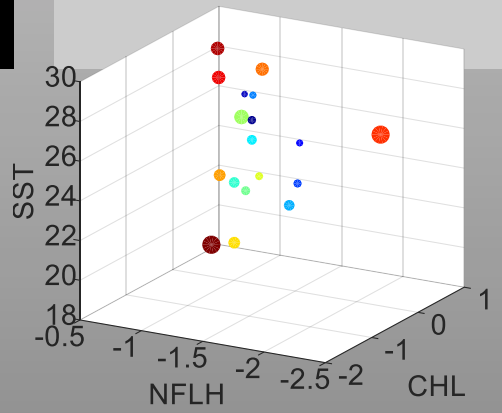
Monterey Bay





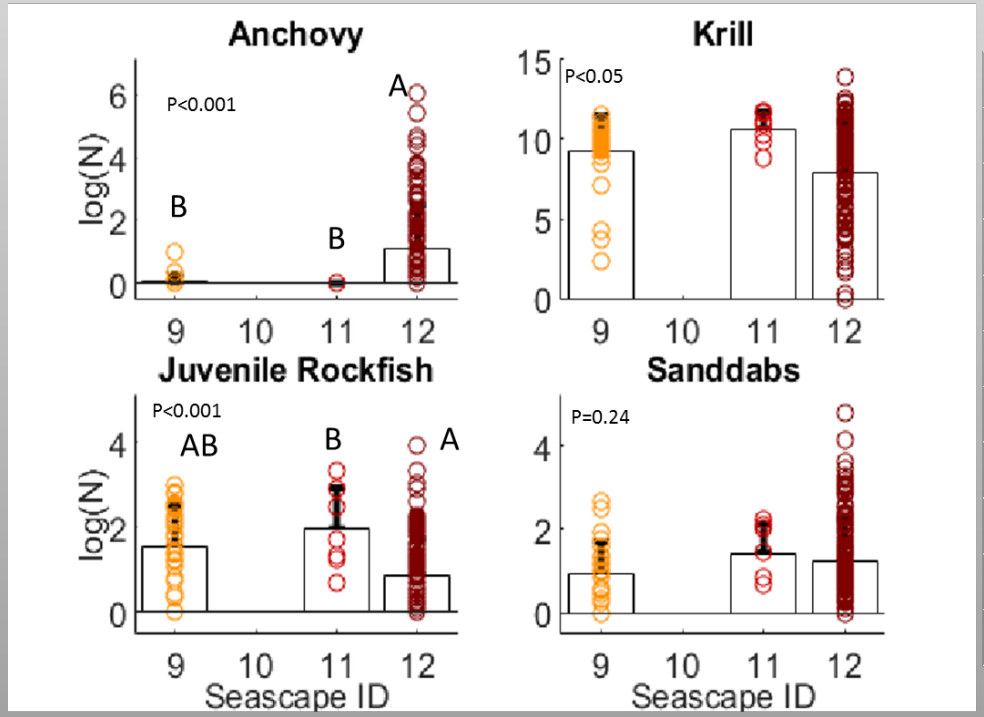
Florida Keys





Seascapes of the MBNMS and Adjacent Areas

Habitat metrics in the MBNMS:
Midwater trawl data 2003-2010



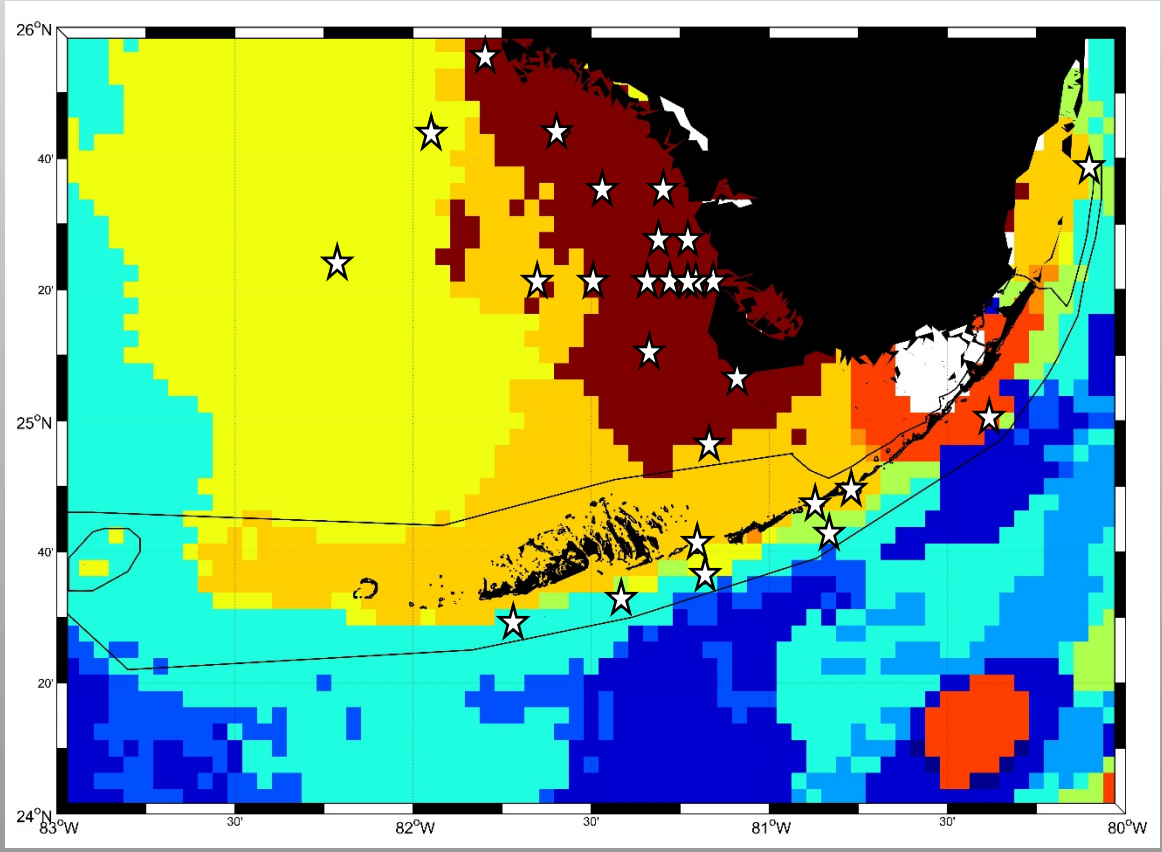
Likelihood Ratio=
N in Seascape X/Total N
Frequency of Seascape X (x,y,t)

Presence				
Seascape ID	Anchovy	Krill	Rockfish	Sanddab
9	0.2	1.0	1.0	0.8
11	0.0	1.0	1.3	1.1
12	1.3	1.0	1.0	1.0
Biomass				
Seascape ID	Anchovy	Krill	Rockfish	Sanddab
9	0.4	0.9	0.9	0.9
11	0.0	1.0	1.2	1.1
12	1.2	1.0	1.0	1.0

Analysis of variance of abundances across seascapes. Letters denote results of multiple comparisons tests, where unique letters have statistically significant different means.

Seascapes of the FKNMS and Adjacent Areas

Seascapes guides habitat metrics validation:
South Florida Program cruise March 14-18, 2016



Stations sampled (28)

- Parameters:
- eDNA
- Zooplankton
- Phytoplankton
- Prim. Production
- Chl-a
- HPLC
- CDOM
- R_{RS}
- Hydrography

Six seascape types sampled

Next cruise: May 9-13, 2016

Seascape weekly composite at 4 km pixel resolution (March 4-11, 2016).

Global Seascapes

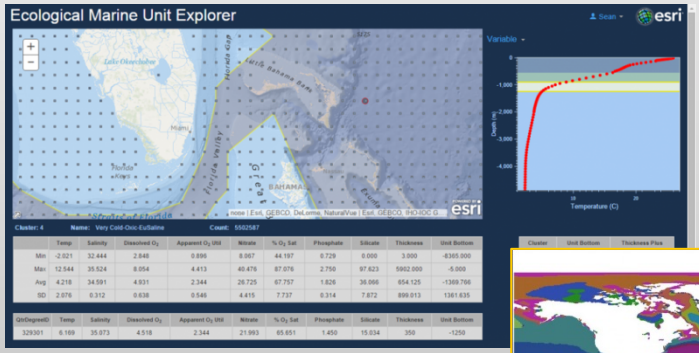
In progress/Next steps:

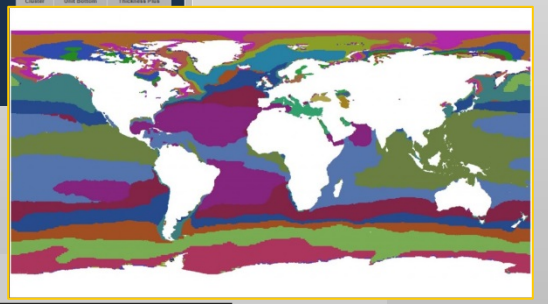
- In situ validation
- Automate data flow between NASA, USF, WHOI, IOOS DMAC / Axiom
- Improving algorithms: Harmful Algal Blooms (HAB), carbonate system
- Expand high-resolution coverage:
  - Flower Garden Banks, AK-BON, Santa Barbara, other NMS
- Evaluate user metrics
- GEOBON and broader links:

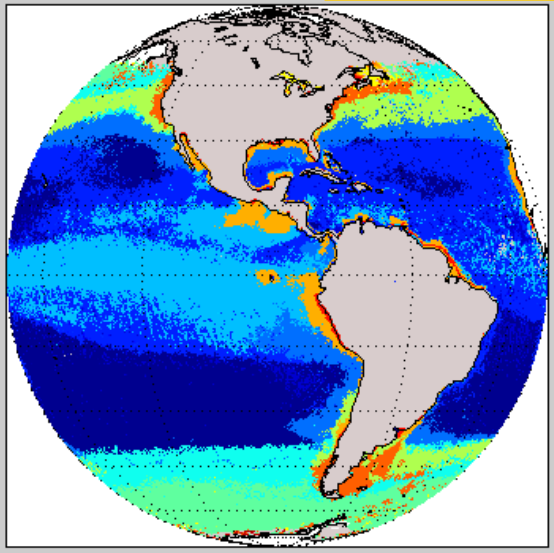
➢ Work with Roger Sayre (USGS) to link remote sensing Seascapes and Ecological Marine Units/EMU (USGS/esri)

  ➢ Pole to Pole Biodiversity and Biogeogeography

➢ Other partners/internationally







Surface ocean EMU

Surface ocean Seascapes

Remote Sensing of Seascapes

Manuscript Accepted:

Kavanaugh, M.T., Oliver, M J., Chavez, F. P., Letelier, R.M., Muller-Karger, F.E., Doney, S.C. 2016 (In press). Seascapes as a new vernacular for ocean monitoring, management and conservation. ICES Journal of Marine Science.

Communications & Outreach

CJ Reynolds, Jennifer Brown

- Newsletter (distributed via all_mbon@marine.usf.edu)

SANCTUARY MBON
Updates from the Florida Keys and Monterey Bay Projects

February 2016

DMAC UPDATE

The DMAC team is revising the data management plan under the leadership of Dave Anderson at CeNCOOS. The Florida and Monterey Bay teams are working on enrollment of historical data sets for ingestion in close collaboration with Philip Goldstein with OBIS-USA. Axiom continues to make progress on data ingestion of Florida and California biological data sets and ingested a large number of Florida Keys National Marine Sanctuary (FKNMS) ecological data GIS layers and several time series data sets.

Eighteen years (1995-2012) of the Reef Visual Census (RVC) data have been transformed from their original forms into the standards-based forms used by OBIS-USA, such as Darwin Core and the Marine BioGeography (MGB) common terms definitions. Guidance for this effort was derived from the "MBG 2.1 Enrollment Journal Florida Marine Sanctuaries Fish 2004 Draft 20140521" produced by Philip Goldstein. The transformed data and metadata were written into NetCDF files and installed in an ERDDAP server making them available through the network via human or URL-based interfaces.

Axiom and a team of Monterey Bay and Florida scientists are working on the development of a generalized biodiversity indices tool. Axiom is working with the RVC data set to prepare it for real-time biodiversity indices calculations. Software engineers have started to incorporate biodiversity indices calculations into backend server side analytical code. The prototype biodiversity indices tool is expected to be available for use with the AXIOM tool in early March. Axiom (along with IOOS and OBIS staff) met with Barbara Block and team at Hopkins Marine station and discussed best paths forward to accessing ATN data relevant to MBON.

The RVC data is available through a GCOOS ERDDAP server. The ERDDAP interface allows users to filter the data, produce maps, and deliver data and metadata in many different formats. Click here; The "Make a Graph" page allows users to plot selected data and export the plots. You can enter constraints by hand or generate the plot directly from here.

Another impressive dataset, the Historical NOAA CTD data for the Florida Keys (30 raw CTD data sets collected from the *R/V Walton Smith* from 2006-2015) have been incorporated into the MBON data management system. Data collected include temperature, salinity, beam attenuation, beam transmission, dissolved oxygen, surface and *in situ* irradiance (PAR). Underway systems collect near-surface temperature, salinity, meteorological and navigation data. Some cruises include current meter data. In the coming month, we will have products from these three-dimensional time series datasets mapped. Additional water quality data will be ingested from http://data.gcoos.org/nutrients/ and other sources to visualize and analyze with the Axiom workspace.

A DMAC X-MBON team has been formed with participants from Alaska, Florida, Monterey Bay, Santa Barbara and the Smithsonian MarineGEO Tennenbaum.

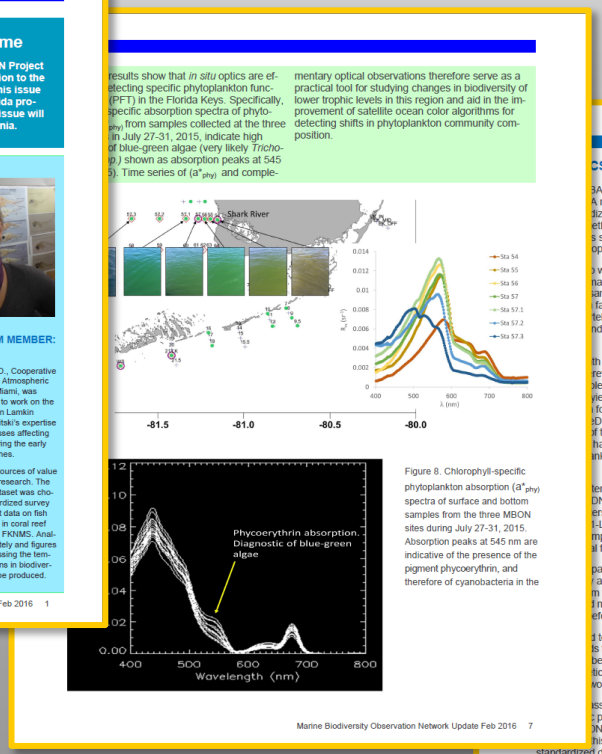
Welcome

to the first MBON Project Update. In addition to the team updates, this issue focuses on Florida projects. The next issue will focus on California.

NEW MBON TEAM MEMBER: NOAA SEFSC

Kathryn Shulzitski, Ph.D., Cooperative Institute for Marine and Atmospheric Studies, University of Miami, was hired in the fall of 2015 to work on the MBON project with John Lamkin (NOAA SEFSC). Shulzitski's expertise is in the study of processes affecting growth and survival during the early life history stages of fishes.

She is analyzing data sources of value for marine biodiversity research. The Reef Visual Census dataset was chosen because its standardized survey methods provide robust data on fish density and distribution in coral reef habitats throughout the FKNMS. Analysis will begin immediately and figures for a manuscript addressing the temporal and spatial patterns in biodiversity in the FKNMS will be produced.



esults show that *in situ* optics are effelecting specific phytoplankton functPFT) in the Florida Keys. Specifically, pecific absorption spectra of phyto$_{phy}$ from samples collected at the three in July 27-31, 2015, indicate high of blue-green algae (very likely *Tricho-p.)* shown as absorption peaks at 545). Time series of (a^*_{phy}) and complementary optical observations therefore serve as a practical tool for studying changes in biodiversity of lower trophic levels in this region and aid in the improvement of satellite ocean color algorithms for detecting shifts in phytoplankton community composition.

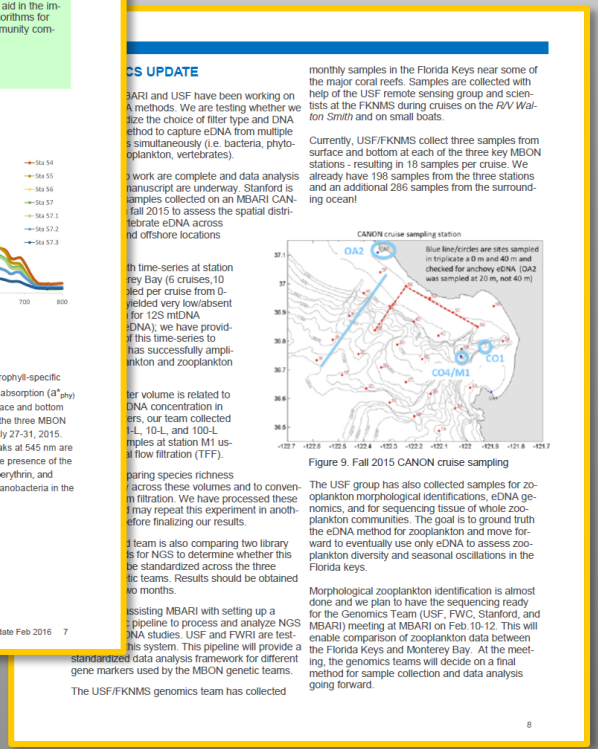
Shark River

-81.5 -81.0 -80.5 -80.0

Phycoerythrin absorption. Diagnostic of blue-green algae

Wavelength (nm)

Figure 8. Chlorophyll-specific phytoplankton absorption (a^*_{phy}) spectra of surface and bottom samples from the three MBON sites during July 27-31, 2015. Absorption peaks at 545 nm are indicative of the presence of the pigment phycoerythrin, and therefore of cyanobacteria in the



CS UPDATE

ARI and USF have been working on A methods. We are testing whether we lize the choice of filter type and DNA ethod to capture eDNA from multiple s simultaneously (i.e. bacteria, phytoplankton, vertebrates).

work are complete and data analysis anuscript are underway. Stanford is amples collected on an MBARI CAN- fall 2015 to assess the spatial distri- tebrate eDNA across nd offshore locations

th time-series at station rey Bay (6 cruises,10 led per cruise from 0- ielded very low/absent for 12S mtDNA DNA); we have provid- f this time-series to has successfully amplinkton and zooplankton

ter volume is related to DNA concentration in ers, our team collected -L, 10-L, and 100-L mples at station M1 us- l flow filtration (TFF).

paring species richness across these volumes and to conven- filtration. We have processed these may repeat this experiment in anoth- efore finalizing our results.

team is also comparing two library is for NGS to determine whether this be standardized across the three tic teams. Results should be obtained o months.

ssisting MBARI with setting up a pipeline to process and analyze NGS NA studies. USF and FWRI are testis system. This pipeline will provide a standardized data analysis framework for different gene markers used by the MBON genetic teams.

The USF/FKNMS genomics team has collected monthly samples in the Florida Keys near some of the major coral reefs. Samples are collected with help of the USF remote sensing group and scientists at the FKNMS during cruises on the *R/V Walton Smith* and on small boats.

Currently, USF/FKNMS collect three samples from surface and bottom at each of the three key MBON stations - resulting in 18 samples per cruise. We already have 198 samples from the three stations and an additional 286 samples from the surrounding ocean!

CANON cruise sampling station

OA2 OAC CO1 CO4/M1

Blue line/circles are sites sampled in triplicate a 0 m and 40 m and checked for anchovy eDNA (OA2 was sampled at 20 m, not 40 m)

Figure 9. Fall 2015 CANON cruise sampling

The USF group has also collected samples for zooplankton morphological identifications, eDNA genomics, and for sequencing tissue of whole zooplankton communities. The goal is to ground truth the eDNA method for zooplankton and move forward to eventually use only eDNA to assess zooplankton diversity and seasonal oscillations in the Florida keys.

Morphological zooplankton identification is almost done and we plan to have the sequencing ready for the Genomics Team (USF, FWC, Stanford, and MBARI) meeting at MBARI on Feb.10-12. This will enable comparison of zooplankton data between the Florida Keys and Monterey Bay. At the meeting, the genomics teams will decide on a final method for sample collection and data analysis going forward.

Will have roughly quarterly distribution

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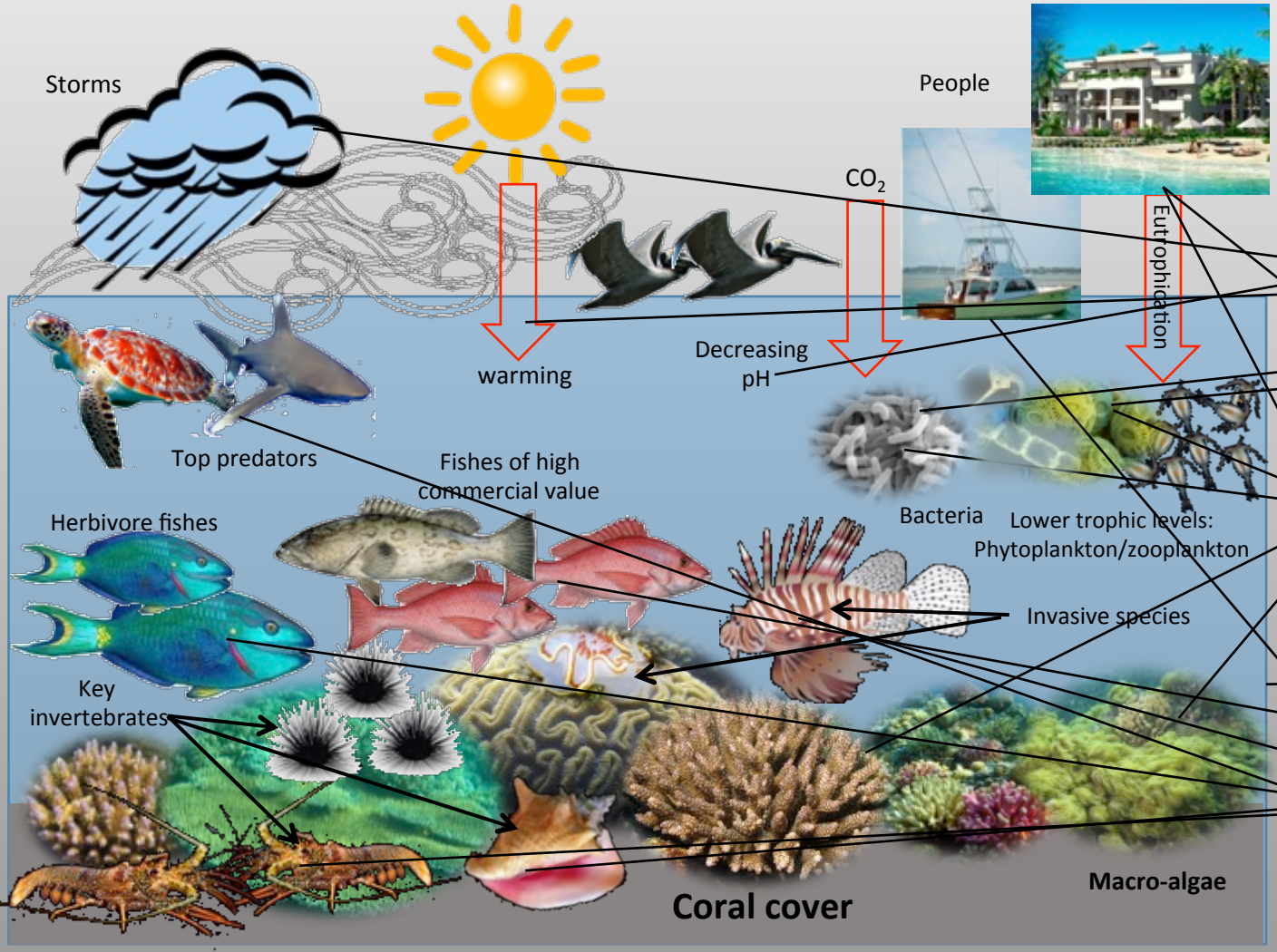
Next steps: Putting it all together

- Build the decision-support tool to answer Sanctuary Condition Report questions

Dynamic support for Condition Reports



Condition Report Questions

WATER:

- Q4: Stressors
- Q1: Eutrophication
- Q2: Human health risks

HABITAT:

- Q5: Habitat dist. / health
- Q14: Human impacts

LIVING RESOURCES:

- Q10: Biodiversity status
- Q17: Fishing status
- Q9: Invasive species
- Q7: Keystone species
- Q8: Focal species
- Q17: Human impacts

Good	Good/Fair	Fair	Fair/Poor	Poor	Undet.

Successes and challenges within the Sanctuaries MBON

Successes:

- **Conceptual framework for collaborative MBON:**
  - **Academic entities**
  - **NOAA programs, State government, international (GEO BON, IOC/GOOS, SBSTTA/ CBD)**
  - **In conversation with several NGOs: MedPAN (Assoc. of Mediterranean Marine Protected Areas managers), Mexican Fund for the Conservation of Nature, etc.**
- **eDNA: collection and extraction methods tested**
- **Satellite-based, dynamic *seascape* products: automated pipeline for input data in place for several MBON regions of interest**
- **Biodiversity field monitoring program implemented in both Sanctuaries**
- **MBON data used to update 2015 Monterey Bay NMS Condition Report**
- **Making links: NOAA *ocean acidification* program, *NOAA Omics*, State and Federal fisheries & environmental monitoring, NSF LTER (Everglades), IOOS and other observation programs**
  - **IOOS GCOOS has funded a Doctoral fellowship at USF to work MBON-LTER-SFP**

Challenges:

- **Development and maintenance of data system / visualization tool:**
  - **The amount of work is staggering – many details**
  - **How to transition to a sustainable model?**
- **eDNA validation at different trophic levels**
  - **For ex. vertebrates in different regions**
- **Curation and permanent archive of biological datasets from various sources:**
  - **Identifying and understanding datasets is an ongoing effort**
  - **How do these data transition into a permanent archive? How do we maintain access needed for operational & research utility?**
  - **How do we engage monitoring programs to enroll data?**
- **Communications flow on news and outreach**
- **Integrating the MBON observations into the FKNMS Condition Report-2017(?)**
- **Coordination of myriad moving parts with partners and X-MBON projects**
- **Building critical international partners and linkages for Pole-to-Pole**
- **Operational MBON**
  - **path to sustainability not clear**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MBON

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X-MBON
Marine Biodiversity Observation Network

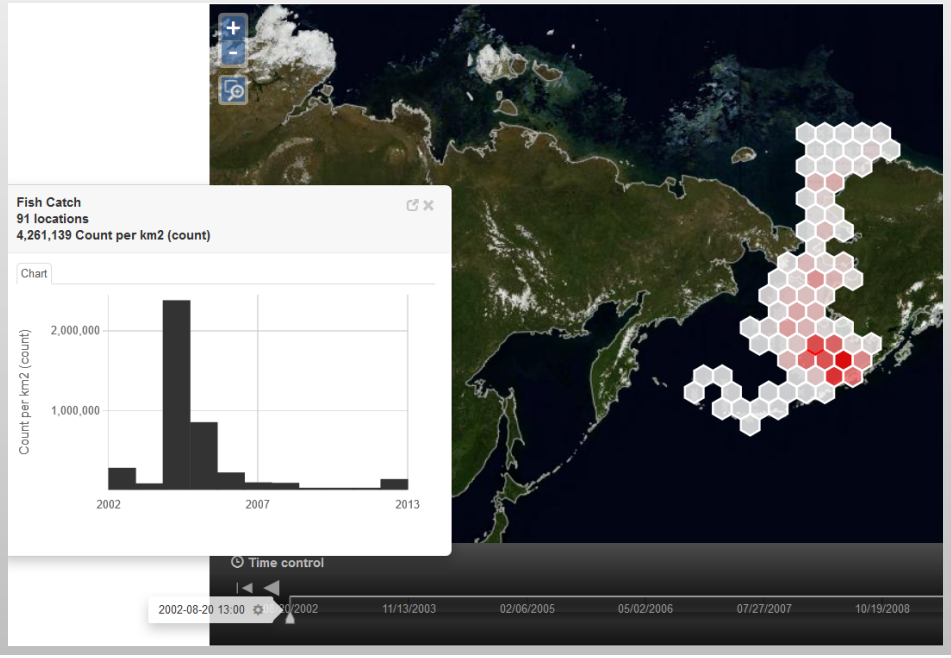
X-MBON team:

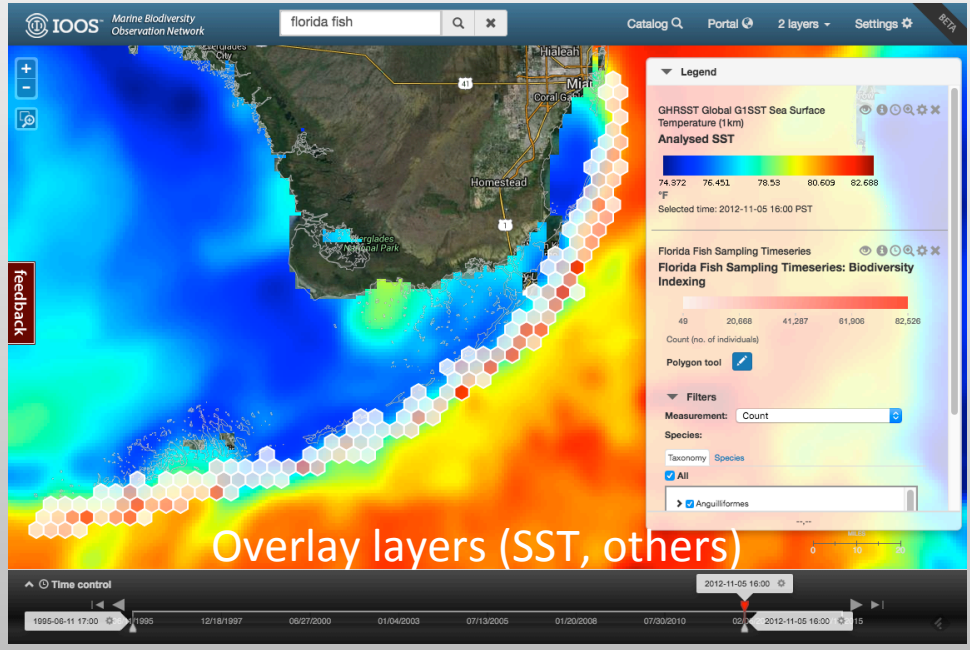
- NOAA IOOS / NASA
- Sanctuaries MBON
- Santa Barbara MBON
- AK MBON
- MarineGEO (Tennenbaum/ SI)
- Conversations with
  - USGS/esri
  - International groups: GEO / GEO BON / AmeriGEOSS / USGS-EMU

Focus of discussions:

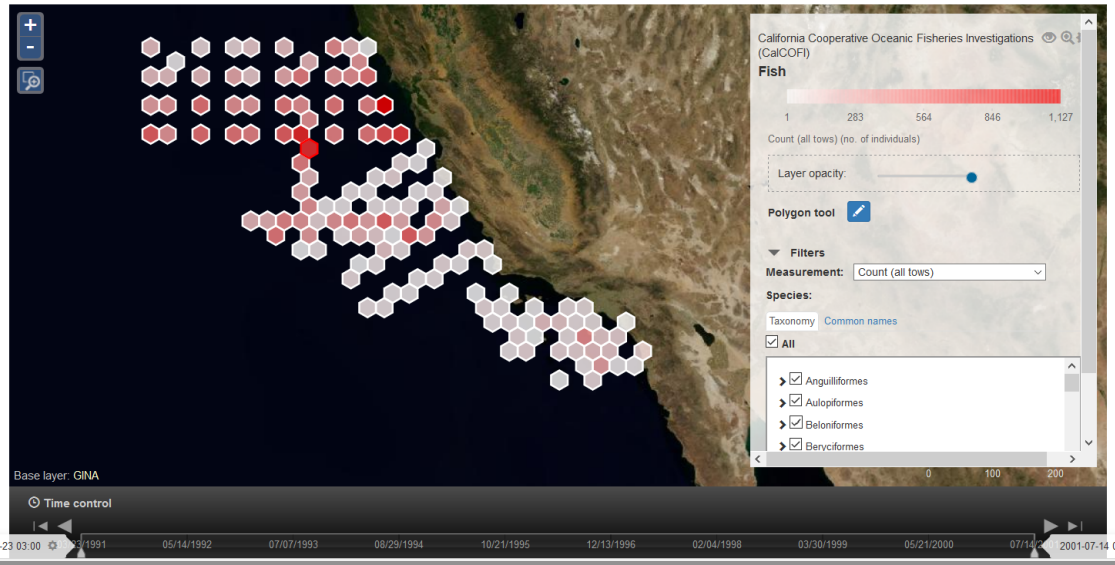
- DMAC (range of topics)
- eDNA (methods)
- EBV's/EOV's / Biodiversity indicators
- Seascapes (coverage, interpretation, validation, improvement)
- Communications/Outreach
- Applications

DMAC: Development of MBON Visualization





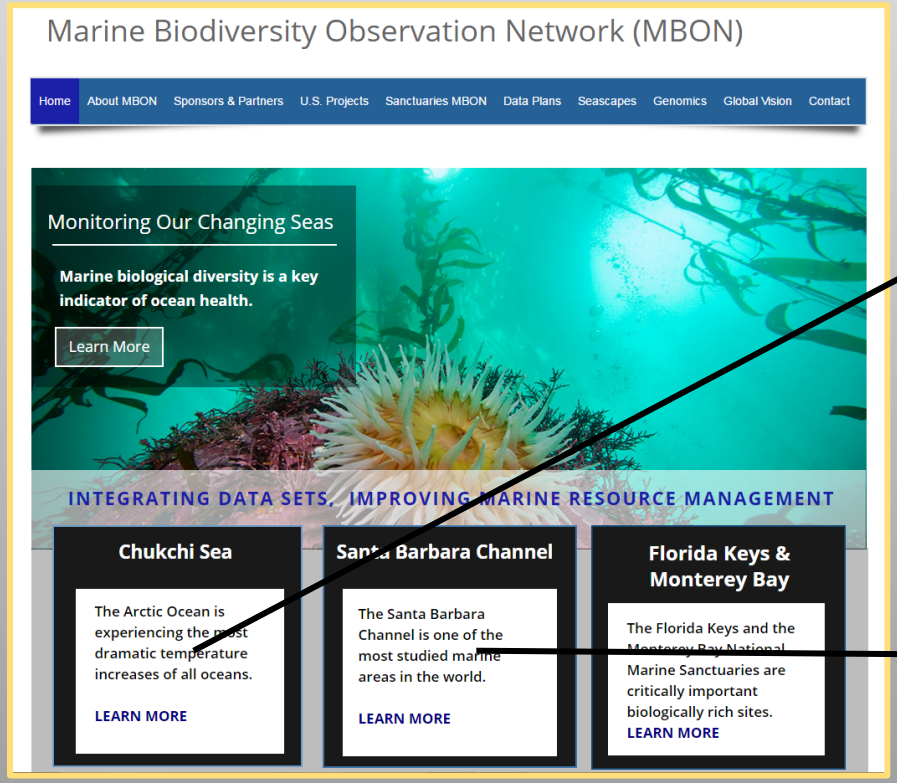
Shannon-Wiener Diversity: This index quantifies the uncertainty associated with species prediction
Pielou's Evenness: Species evenness quantifies how close in count each species is within a sampling event

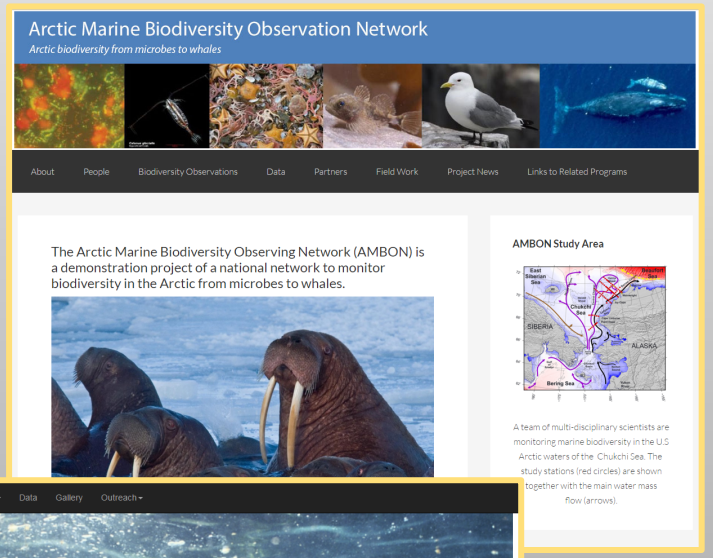


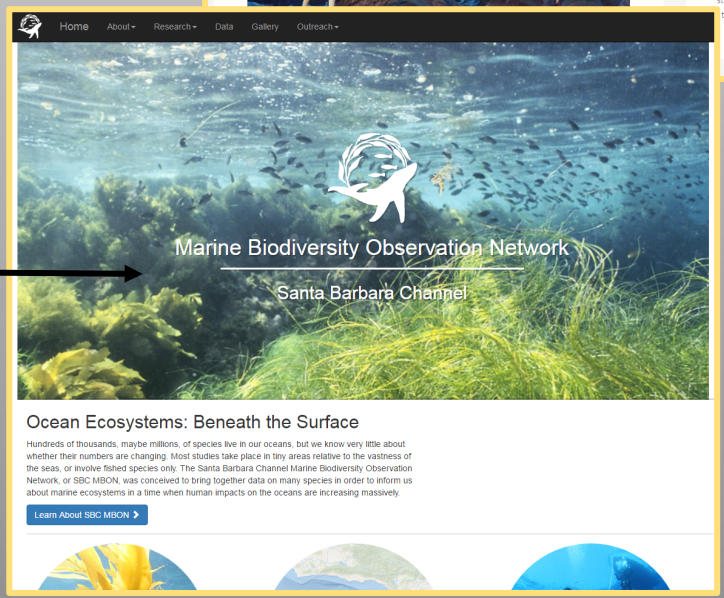
Biological diversity indices are being incorporated across various regions and for different datasets

Communications & Outreach

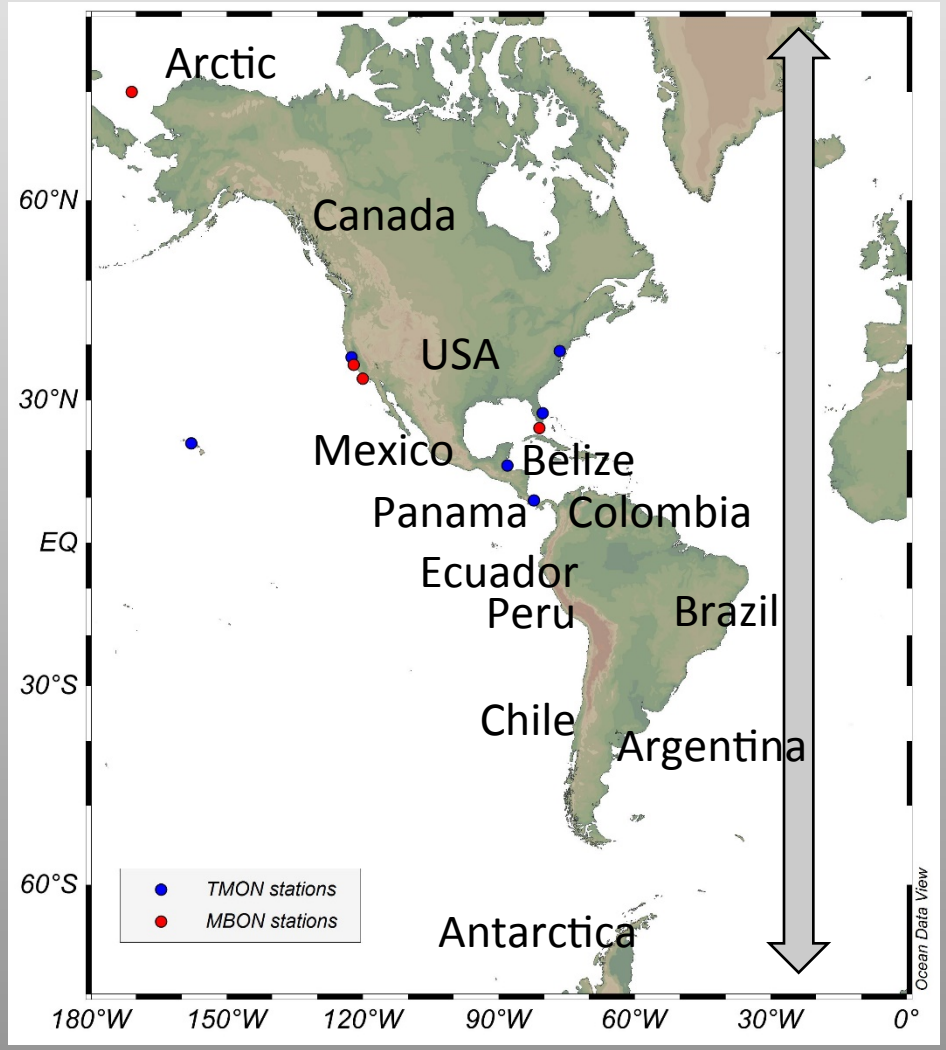
- Sanctuaries MBON Website (http://www.marinebon.org/)







MBON beyond the US: GEO, GOOS, CBD



GOALS:

- **Pole-to-Pole MBON pilot**
  - **the Americas**
- **BON in a Box**

Outreach and planning

- MBON presentations at GEO Plenary, Mexico (2015)
- MBON presentation at the Convention of Biological Diversity (Montreal, Apr 24, 2016)
- GEO BON Open Science Meeting (Leipzig, Jul 4-6,2016)
- GEO MBON All-Hands Workshop (Leipzig, Jul 6-7,2016)
- Pole-to-Pole in the Americas Workshop (Puerto Morelos, Mexico, Sep 26-30, 2016)
- MBON presentation at the GEO-XIII Plenary (St Petersburg, Russia, Nov 9-10, 2016)

X-MBON
Marine Biodiversity Observation Network

Successes and challenges

Successes:

- Frequent and dynamic communications
- Active discussions on:
  - eDNA
  - Seascapes
  - DMAC: enrollment, visualization, and analysis
  - EBV's/EOV's / Biodiversity indicators
  - Applications
- Collaboration with international groups:
  - GEO / GEO BON / AmeriGEOSS / USGS-EMU
  - Pole to pole MBON idea has traction

Successes and challenges

Challenges:

- AMBON is not fully funded
- DMAC underfunded
- Definition of biodiversity monitoring priorities for contrasting ecosystems (from tropics to Arctic)
- Entraining additional areas/regions/programs:
  - In the US
  - Internationally
- Sustaining operations
- Time is ticking…